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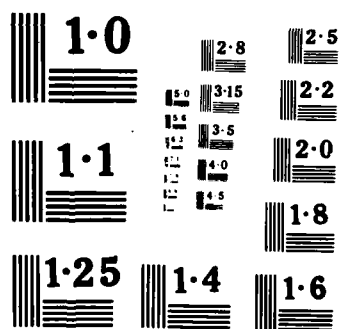
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1983 - 1984



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SUMMARY REPORTS
OF
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FOR
FISCAL YEAR 1984

NOVEMBER 1984
UNITED STATES NAVAL ACADEMY
ANNAPOLIS, MARYLAND

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FOREWORD

It is the policy of the Naval Academy to provide and maintain an environment in which research activities that contribute to the professional growth of the faculty and outstanding midshipmen may flourish.

One important ingredient of the Naval Academy research program is the base or "seed money" provided by the Chief of Naval Research. These funds support a broad program of Independent Research and are used for Naval Academy Research Council faculty research grants and midshipmen Trident Scholar projects. Once a project is started and looks promising, it is usually funded in full by another sponsor.

This report contains summary reports of faculty projects selected and supported by the Naval Academy Research Council during Fiscal Year 1984.

R. D. Mathieu

RICHARD D. MATHIEU
Director of Research and
Associate Dean



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TITLE: Lordship and Military Obligation in Anglo-Saxon England

INVESTIGATOR: Assistant Professor Richard P. Abels, History Department

BACKGROUND: The subject of my research project is a study of military obligation in England from the seventh-to the eleventh-century. In it I analyze the manner in which military institutions and the practice of war were affected by changes in Anglo-Saxon land tenure, by the challenge of the Viking invasions, and by the growth of royal lordship. The aim of this study is to answer a specific question that has wide-ranging implications for medieval military and social history: what was the precise relationship between the obligations that arose from the lordship bond and military service in pre-Conquest England? The answer to this question will help to clarify one of the knottiest problems in English history, namely the impact of the Norman Conquest upon the military organization of England.

I will attempt to show through an analysis of the literary and archaeological evidence that lordship played a crucial role in English military institutions throughout the Anglo-Saxon period. This is most clear in the pre-Viking period. The traditional view that early Anglo-Saxon armies consisted of free peasants defending the folk appears to be mistaken. Rather, early royal armies were little more than war-bands, composed of the king's retainers and their own followers. Each warrior fought as a commended man serving his lord. Because of a number of factors, most notably the introduction of hereditary tenures by the Church and the ravages of the Viking invasions, this military system changed greatly from the seventh-to the eleventh-century. By 1066, the amount of military service that a man owed the king was defined by the amount of land that he held. Lordship, however, continued to play a crucial role in the armies of late Anglo-Saxon England, for it was the lordship bond that cemented these forces. Thus the tenth- and eleventh-century kings attempted to strengthen their hold upon the landholders of the realm by demanding of them oaths of fealty, modeled closely upon the oath of commendation. In addition, the royal host was organized so that each man fought under the command of his lord. Lordship and land tenure thus provided the twin pillars upon which the military organization of late Anglo-Saxon England rested.

OBJECTIVE: I am preparing a book-length study of military obligation and lordship in Anglo-Saxon England and am making presentations and writing articles on this subject.

METHOD: My study will be based on a careful examination of the written contemporary sources and the archaeological record. The techniques that I employ include statistical analysis of data from Domesday Book, charter criticism, family reconstruction, semantic studies of key terms such as "ceorl" and "fyrd," and a pioneer analysis of the geography of Anglo-Saxon lordship.

RESULTS: In the summer of 1984 I completed my research into the relationship between geography and lordship in late Anglo-Saxon England. The pattern that emerged confirmed my earlier suspicions: not only was geography a crucial determinant in the selection of a lord, but lesser men tended to

seek lords among the magnates of their hundreds and shires, patrons who could defend them in the folk courts. I also began work on the actual organization of the late Saxon royal army. My research consisted of examining the relevant charters and literary sources for evidence concerning the levying of armies, the structure of these forces, and nature of their logistical support system. I also combed the relevant entries in Healy and Venezky, eds., A Microfiche Concordance to Old English, for references to military captains in an attempt to identify the leaders of the eleventh-century fyrds and discover their relationship to the king. The results of this research will be presented in November 1984 at a professional conference. Finally, I spent a good part of the summer rewriting and reworking four of the nine chapters of my book, about 150 pages in all. One of these chapters was also revised and expanded into a paper that I presented last July at a professional conference held on the site of the battle of Hastings. This paper was subsequently accepted for the annual Proceedings of that conference.

STATUS: I have completed most of the research for my book and have revised about three-quarters of the manuscript. I still have another two chapters to rework and revise before I will be able to submit my monograph to a university press. I hope to be finished by the end of this academic year.

PUBLICATIONS:

- a) "The Devolution of Bookland in Ninth-Century Kent," Archaeologia Cantiana, vol. xcix (1983).
- b) "Bookland and Fyrd Service in Late Saxon England," in Anglo-Norman Studies VII: Proceedings of the Battle Conference 1984 (forthcoming: July 1985).

PRESENTATIONS:

- a) "The Introduction of Bookland Tenure and the Military Crisis of the Eighth Century," Second Annual Conference of the Haskins Society, University of Houston, 11-13 November 1983.
- b) "The Worcestershire and Berkshire Domesday Customals," Nineteenth International Congress on Medieval Studies, Western Michigan University, 10-13 May 1984.
- c) "Bookland and Fyrd Service in Late Saxon England," Seventh Battle Conference on Anglo-Norman Studies, Battle Abbey, East Sussex, Great Britain, 20-25 July 1984.
- d) "The Organization of the Late Saxon Fyrd," Third Annual Conference of the Haskins Society, University of Houston, 9-11 November 1984

TITLE: Argentina's Foreign Policy

INVESTIGATOR: Professor G. Pope Atkins, Political Science Department

BACKGROUND: Argentine foreign policies are best understood by organizing analysis around six networks of relations and establishing the linkages among them. These networks involve relations (1) within the domestic Argentine political-social-economic system; (2) with European nations and organizations; (3) with the United States and other Latin American states in the context of the Inter-American System; (4) in the regional South American southern cone, South Atlantic, and Antarctic; (5) with the Third World outside the Americas; and (6) with the communist bloc. Each of these environments has presented distinct situational considerations for Argentine policy makers, who have established clear, although shifting, priorities among them and adopted different policy ends, means, and strategies toward each.

The question of "why" is considered regarding two principal themes: (1) Argentina's foreign policy failure and international decline, despite its former position as Latin America's leading nation on the threshold of great power status; and (2) Argentina's inability to coordinate its actions in the six networks of relations, although it has at times been effective in individual arenas.

OBJECTIVE: The purpose of the project is to complete a book-length manuscript about the foreign policies of Argentina. The study aims to identify, describe, and analyze the principal characteristics of Argentina's foreign policies, to explain that nation's international behavior, and to understand the reasons behind the rise and decline of a global middle power from the Latin American region.

METHODOLOGY AND RESULTS: Data have been collected in the following categories: (1) a careful review of related extant theory; (2) the extensive material from Argentina issued in Spanish from official, scholarly, and news sources; (3) secondary materials from U. S., British, German, French, and Italian sources; and (4) interviews and correspondence with Argentine officials, scholars, and journalists.

More challenging than data collection is development of an analytic framework. Understanding Argentina's foreign policies and international politics is complicated by the fact that its orientations have not conformed to standard analytic models, such as theories of isolationism, alliance, development, and dependency. Consequently, analysis must acknowledge the dearth of guiding frameworks and develop a set of definitions and concepts suitable for accurate evaluation of the Argentine case. The result has been an organizing device viewing foreign policy processes and outcomes primarily as functions of the diverse environments within which Argentine policy makers must operate.

STATUS: The book has been organized by chapters in note form, and writing of a smooth manuscript has begun and is continuing. A trip to Argentina to conduct interviews and review recent materials difficult to obtain outside the country would be desirable in view of the dramatically changed political situation there.

PUBLICATIONS: "Conflict Resolution in the Southern Cone," Bulletin of Latin American Research, (Oxford, England) Vol. 4, No. 2, (January 1984), 15-18.

PRESENTATIONS: "Formulation of Foreign Policy in Argentina", to faculty and graduate students, International Relations Department, London School of Economics and Political Science, 12 October 1984.

TITLE: Even Hamiltonian Paths

INVESTIGATOR: Assistant Professor Craig K. Bailey, Mathematics Department

BACKGROUND:

A graph is a finite collection of points and lines. A path is a sequence of points with each point connected to the one before it in the sequence by a line. A path is a Hamiltonian path if it passes through all the points of the graph.

A graph with a Hamiltonian path can have the numbers $1, 2, 3, \dots, n$ assigned to its points such that the point labeled i is adjacent to the point labeled $i-1$ for $i = 2, 3, \dots, n$. A graph with an even Hamiltonian path can have the numbers $1, 2, 3, \dots, n$ assigned to its points such that:

a) the point labeled i is adjacent to the point labeled $i-1$ for $i = 2, 3, \dots, n$.

and

b) the point labeled i is adjacent to an even number of the points labeled $1, 2, \dots, i-1$ for $i = 3, 4, \dots, n$.

OBJECTIVE:

The object of the study was to extend work done on a narrow class of graphs which existed in the plane to a broad range of graphs by replacing topological properties with graphical properties.

METHODOLOGY AND RESULTS:

A clique in a graph is a maximal subset of the points of the graph in which each pair of points is connected by a line. A graph may have several cliques of various sizes.

It was determined that graphs with uniform clique size which overlapped in special ways (simulating the overlap which occurs for graphs in the plane) could not have even Hamiltonian paths.

STATUS:

Conditions are being sought which will guarantee the existence of even Hamiltonian paths. Results of this type for Hamiltonian paths use the existence of large cliques in a graph in a positive way, just the opposite of what is needed here.

PUBLICATIONS:

C. K. Bailey, M. E. Kidwell, "A King's Tour of the Chessboard," submitted.

PRESENTATIONS:

A King's Tour of the Chessboard, Washington and Lee Mathematics Department Colloquium, Lexington, Virginia.

PRESENTATIONS: As a result of my talks with Lukács scholars last summer, I received several invitations to present papers at conferences in Europe and the USA. 1. On Lukács' concept of reification and Utopia (March 1985, in Paris, Goethe Institute). 2. The role of the intellectual after Lukács (May 1985, at the Université Libre de Bruxelles). 3. On one aspect of Lukács' literary criticism (August 1985, at the ICIA conference in Paris). 4. In the case that I can get to Europe during the school year, I was invited to lecture at the Ecole des Hautes Etudes en Sciences Sociales in Paris, at a seminar conducted by Professor Nicolas Tertulian. A similar offer was extended to me by Professor Ralph Heyndels from the Université Libre de Bruxelles to give several lectures at two or three neighboring universities in the Netherlands. 5. In the USA, December 1984, I am scheduled to read a paper on Lukács' theories of the historical novel at the MLA Congress in Washington, D. C.

1. In Budapest, I spent the first three days (a weekend and the national holiday on August 20) familiarizing myself again with Budapest and the Hungarian language while visiting with some members of my family. From August 21 to the end of my stay in Europe, I participated fully in the work of the FILLM conference to which I had been invited. My paper, entitled "Constitution et fragmentation du soi des Essais de Montaigne au Roland Barthes par Roland Barthes," was very well received. It consists of a diachronic study of the form of autobiographical writing, inspired by Lukácsian methodology. Because of the diversity and top quality of the scholars I met at this international meeting, the week in Budapest seems to have been a most rewarding finale to my work last summer. I was able to have interesting and very informative discussions with colleagues in my field from all over the world, listen to their papers and the comments that followed their presentation. For instance, the paper of the major Soviet representative from Moscow University was subsequently commented on by a critique from Czechoslovakia and, in smaller circles, by scholars from Brazil, Montreal and Hungary. I was grateful to possess the linguistic background that allowed me to participate in all discussions and understand all the papers that were presented at the meeting. A further highlight of my stay in Budapest was my visit to the Archives of Lukács and the ensuing conversations I had with several of their administrators. It was a completely different crew from the one I had met during my previous visit in 1976. In our conversations, I was able to detect some of the ideological shifts that had taken place. It was interesting that none of the former government-endorsed Lukács scholars of 1976 were present at this 1984 meeting. I left a copy of my most recent study of Lukács at the Archives, where two of the archivists were well acquainted with my dissertation and previous work on Lukács. They expressed interest in providing me with further information and documents from the Archives and discussed the possibility of my translating some of Lukács' Hungarian texts for publication in the USA.

STATUS: The research for my manuscript is practically complete. Some correspondence over the next few months should provide the materials I am still missing, such as a few pieces of illustrative materials and copies of letters I was promised by the managers of Lukács' Archives, and a very recent, apparently very complete critical bibliography of Lukács' work that just appeared in the USA.

PUBLICATIONS: Review of Four Critics: Croce, Valéry, Lukács, and Ingarden, by René Wellek (Seattle: University of Washington Press, 1983), in Philosophy and Literature, Vol. 8, No. 1 (April 1984), pp. 134-135.

Other publications relative to this project are forthcoming:

1. An abstract of the paper I presented in Budapest, "Constitution et fragmentation du soi des Essais de Montaigne au Roland Barthes par Roland Barthes," will be included in the published Proceedings of the FILLM Conference. This is a "Lukácsian" analysis of the changing form of autobiography.

2. "Les Fins du roman," which is an analysis of Lukács' concept of the epic, is due to appear at the end of 1984 in France.

3. I was asked to contribute a chapter to a collection of essays, edited by Joseph Latoli, on "Influences on Postmodern Literary Theory and Criticism."

4. The editors of Philosophy and Literature asked me to review for their journal a recent book on Roman Ingarden, the Polish philosopher, who was Lukács' contemporary.

TITLE: The Modernisms of György Lukács: A Study of His Literary Criticism

INVESTIGATOR: Assistant Professor Eva L. Corredor, Language Studies Department

BACKGROUND: Since the mid-nineteen sixties, the work of the Hungarian philosopher and critic György Lukács has attracted considerable attention in all disciplines concerned with the study of Western thought, such as literature, philosophy, history, sociology and politics. In the course of the last decade, a plethora of dissertations, papers and several books have been published on his work and development in general. His name is frequently mentioned in relation to literary theory, since he wrote extensively on Goethe, Balzac, Cervantes, Shakespeare, Dostoevsky, Thomas Mann and most other major figures of Western literature. It is therefore surprising that no one as yet has dealt with his work globally and from a specifically literary point of view.

OBJECTIVE: The purpose of this study was to complete research on a manuscript to be published as the first comprehensive book on György Lukács' literary criticism.

METHODOLOGY: Since Lukács' ideas developed gradually under the influences of the philosophies of Aristotle, Kant, Hegel, Nietzsche and Marx, the only logical way of treating his work was chronologically and historically. In all his work, Lukács seems to battle with the concept and experience of "modernism," a phenomenon attributed to developments in recent history. This study therefore focuses on the complex dichotomies surrounding the "modernist self" that are at the heart of Lukács' literary theories.

RESULTS: The major purpose of my work this summer was to verify the accuracy of my interpretation of Lukács' theories. This was accomplished in several steps:

1. With the help of the results of a survey conducted by DIALOG Information Retrieval Service of Nimitz Library, USNA, a systematic research of the topic was carried out in Paris at the Bibliothèque Nationale and the Bibliothèque des Sciences de l'Homme. This required about eighteen days in June and July. Concurrently, during lunch hours, evenings and weekends, several interviews were arranged with scholars who have excellent knowledge of Lukács' work, such as Nicolas Tertulian, Annie Goldmann and Jacques Leenhardt. These resulted in a wealth of information on current Lukács studies and allowed me to test my own views. I was provided with copies of recent and still unpublished articles and received invaluable directions in my efforts to locate recent studies in journals and obtain copies of dissertations that would be of importance to my work.

2. In Germany, I checked the files of the University of Heidelberg for further publications, since several "Lukácsian" scholars had been visiting professors there in recent years. The available material was very interesting to the formulation of my thesis and allowed me to acquaint myself with some East-European and Soviet interpretations of Lukács' work. Most of my time in Germany, however, was devoted to the study and reassessment of the information I had obtained that far. I also worked on the completion of a paper to be presented at a conference in August.

administer the Navy during the early months of 1649 when the entire administrative framework of the Navy and the government was in turmoil. My research this summer has confirmed my beliefs. More importantly, however, evidence from the Committee's Minute Book dealing with the participants in the 1648 Naval Revolt and who were still in their positions by early 1649 shows that the sentiments and enthusiasm for the Naval Revolt was far more widespread within the Navy than believed by modern scholars. A study of the Committee for Regulation will thus shed new light on the Naval Revolt and the political beliefs of those men connected with the Navy during this disruptive and chaotic period.

STATUS: Research for this project is now complete thanks to the weeks spent in England last summer. I have completed the rough draft of this project, and I hope to complete the article and submit it to a learned journal by the end of this calendar year.

PUBLICATIONS: None

PRESENTATIONS: "The Theological Origins of Fifth-Monarchism", delivered to the St. Edmund Hall, Oxford University, Graduate Society, 1980
"The Tactic of Line-Ahead in the Seventeenth Century: Two Schools of Thought", delivered to the Tau Chapter of Phi Alpha Theta Honorary History Society, University of Kentucky, May, 1975

TITLE: Purging the English Navy: An Examination of the Committee for Regulation, 1649-1653

INVESTIGATOR: William B. Cogar, Assistant Professor, History Department

BACKGROUND: When the English Civil War erupted in 1642, the Navy almost unanimously supported the Parliament against King Charles I. In doing so, it played a vital and important role in the Parliamentary cause. The coasts were secured, and the Royalists were thus denied military and material assistance from abroad. The Navy remained an enthusiastic supporter of the Parliament until the summer of 1648 when the Army and the radicals in the House of Commons demanded the dissolution of the monarchy, the establishment of a unicameral republican Commonwealth, and the institution of radical social and religious programs. This caused a part of the Navy to revolt from the Parliament and to place itself under the command of the exiled royalists in Holland.

Once the King was executed and the new Commonwealth established, the new regime promptly recognized the value and immediate need of a strong and loyal naval force to help cement its political position. Within the Navy and its administrative hierarchy on shore, however, there remained a considerable number of men who had either sided or supported in principle the naval revolt. For this reason, the Parliament created a "Committee for Regulation", consisting of zealous and radical London merchants, to purge the Navy of those malignant and disaffected elements. This Committee sat from early 1649 through the spring of 1653. My goal is to assess the Committee's membership and to determine why the new regime turned to London merchants and to those specific individuals for this task. It is hoped that a greater understanding of the administrative procedures and the political sentiments of the Navy and those connected with it during this period of great dislocation will be achieved.

OBJECTIVES: I intend to write an article on the Committee for a learned journal published in either this country or in the United Kingdom.

METHODOLOGY: Since there is no major study on the Committee for Regulation, practically all research must be made from primary documents and sources in England. The most important source on the Committee is the recently-discovered Minute Book of the Committee's proceedings which, although far from complete, gives much valuable and interesting information on the Committee's activities and membership. This Minute Book is presently housed in the Armoury Library of the Tower of London. In addition to this source, other primary documents provide essential information. These include the State Papers in the Public Record Office, the Rawlinson and Tanner Manuscripts in the Bodleian Library in Oxford, the Harleian, Stowe, Sloane and Additional Manuscripts in the British Museum in London, and the Penn Manuscripts found at the National Maritime Museum at Greenwich. All of these collections of manuscripts are valuable sources for the mid-17th century.

RESULTS: Nearly eight weeks of last summer were spent in England and specifically in London and Oxford examining the various sources mentioned above. Naturally, most of my time was spent with the Committee's Minute Book. In transcribing the work and assessing its value, some very interesting questions were raised. I had concluded earlier when I was working on my doctoral dissertation that the Committee for Regulation helped to

decisions spawned by these regulations and prior alleged abuses is still in the process of being sorted out by the judiciary.

STATUS: This was a three week project with a considerable amount of additional effort committed to the effort as time permits. A rough draft manuscript has been prepared. However additional case analysis is necessary to complete the project and produce a final draft. I hope to find additional time to complete the project during the academic year.

PUBLICATIONS: None at present.

PRESENTATIONS: None at present.

TITLE: Congress and the Law of Intelligence: New Directions

INVESTIGATOR: Professor Charles L. Cochran, Political Science Department

BACKGROUND: Prior to 1974, Congressional oversight of the intelligence community was perfunctory. While there were briefings given to those Congressional committees charged with overseeing intelligence matters, these committees did not probe deeply into what the intelligence community was doing or how it did it. All this changed dramatically in the aftermath of public revelations of abuses that had been carried out by some members of the intelligence community. The relationship changed from being supportive, to investigative and adversarial. Upon completion of the investigations by the Pike and Church Committees in 1976, Congressional oversight moved into a new phase. Permanent Select Committees on Intelligence in both the House and Senate were established. Both are supported by large staffs. Oversight is now continuous, thorough, and open with only sources and, at times, methods being withheld from the oversight committees and their staffs. A new and healthier relationship has gradually evolved - the oversight committees are less adversarial but remain alert and probing. The intelligence community, in turn, has gained an avid consumer of its product as the Congress has learned more about the community's capabilities.

OBJECTIVE: The objective is to examine how Congressional involvement in the intelligence process has affected the law regulating intelligence through legislation. A secondary objective was to examine judicial decisions and their impact on the law and subsequent Congressional reaction.

METHOD: The Church and Pike Committee Hearings were reviewed with a view to documenting the abuses and the Congressional reaction in the form of resolutions and legislation. A series of Executive Orders to regulate the intelligence community has also been analyzed. The much larger task of examining the influence of the Judiciary in this whole process is also required.

RESULTS: The Congressional investigations were begun as a result of revelations of abuses in the media and through lawsuits. Congressional investigations resulting in new legislation to regulate the intelligence community were rather swift in their implementation. Several reforms were ill-advised and have been repealed. While the intelligence community chafes under some of the regulations, others clearly have strengthened their capabilities. The myriad of court cases and judicial

PUBLICATIONS:

R. E. Bruninga, "EASTNET, An East Coast Packet Radio Network", Proceedings of the Third ARRL Amateur Radio Computer Networking Conference, April 1984.

R. E. Bruninga, "HF Packets, Modems and Gateways", Proceedings of the Third ARRL Amateur Radio Computer Networking Conference, April 1984.

R. E. Bruninga, "Linking Personal Computers by Packet Radio", Proceedings, The Small Computer (R)Evolution" COMPCON 84 Fall, 16-20 September 1984.

PRESENTATIONS:

The publications above were each presented at the listed conferences. In addition, several other presentations were made to local groups and organizations as follows:

IEEE Man, Computers and Cybernetics Society, Washington, DC, 16 July 1984.

Goddard Space Flight Center, Summer Faculty Fellowship Colloquia 20 July 1984.

George Washington University, Mobile Communications Engineering Course, 19 August 1984.

IEEE Student Chapter, U. S. Naval Academy, 27 August 1984.

Naval Research Labs Amateur Radio Club, 6 September 1984.

Anne Arundel Radio Club, February 1984.

Maryland Mobileers Amateur Radio Club, March 1984.

Amateur Radio Research and Development Organization, Vienna, Virginia, May 1984.

TITLE: A Network Protocol for Wireless Digital Communications

INVESTIGATOR: Commander Robert E. Bruninga, Electrical Engineering Department

BACKGROUND: Digital Packet switching technology has a direct application in the implementation of local area networks (LAN's) using radio as the transmission medium. The advantages of multiple access and broadcast radio channels for information distribution and computer communications have been established and several experimental digital radio networks are in operation. Several technical problems exist in optimizing bandwidth, area coverage, speed, security, capacity, and spectrum economy. For these reasons, radio linked local area networks are still in their infancy and developmental stages.

OBJECTIVE: The objective of this research was to explore existing and proposed network protocols for adaptation to a local area radio linked network for portable or mobile terminals. Such operation would be explored by designing and demonstrating a briefcase portable terminal system which could be radio linked to the Naval Academy Time Share computer system.

METHODOLOGY AND RESULTS: For implementing a radio linked local area network, a version of the popular CCITT X.25 recommendation for digital networking has evolved into an experimental radio standard known as AX.25. This protocol based on a carrier sense multiple access (CSMA) is directly applicable to VHF radio operation. Three protocol terminal node controllers were obtained and interfaced to VHF transceivers for the demonstration phase of the project. Interest in the system extended to many other colleagues in the greater Washington DC area and a local area network with over 25 stations evolved. To extend coverage, radio repeater sites were located on the WDVM channel 9 TV tower in Washington, DC, at Johns Hopkins Applied Physics Laboratories, at the Naval Academy, and at Elk Neck, Maryland at the head of the Chesapeake Bay. Other groups along the northeast coast have extended the network as far north as Boston. After the local VHF network was demonstrated, experiments were conducted with High Frequency (HF) gateways to extend the local area network to a greater region of the country. Since mid March 1984, two of the FNC's have been dedicated to a gateway implemented on a VIC-20 computer which allows stations from as far away as Arizona and California to join the network. There are 13 stations across the country which have joined in the HF experiments.

STATUS: The popularity of the system has approached the maximum channel capacity and two additional frequencies have been allocated in the greater Washington area for Packet Radio operation. The need to develop faster hardware and radio channel modems has been exacerbated by the significant increase in network activity as the repeaters extend coverage up the coast. The HF gateway has been expanded to provide a MAIL system to help overcome the unpredictability of the HF channel and to improve communications among the stations participating in the further development of the network. The vagaries of HF, however, have spawned an interest in meteor scatter communications which has the promise of consistent 24 hour per day coverage at high data rate bursts with ranges out to about 1500 miles. The emphasis of the second year effort of this project will be to develop a suitable protocol to maximize the effectiveness of meteor scatter communications for extending the local area network.

STATUS: I have rewritten much of the manuscript and plan to finish some time this year, at which point I will resubmit it to an interested publisher. I am also presenting some of my work to scholarly meetings this year, and will have at least one piece published soon.

PUBLICATIONS: "Beyond the Barriers: Popular Culture and Parisian Guinguettes in the Eighteenth-Century," Eighteenth-Century Studies (forthcoming).

PRESENTATIONS: "Drinking Groups and Social Networks in Eighteenth-Century Paris," to be presented at the annual meeting of the Social Science History Association, in Toronto, Canada, on 27 October 1984.

"Drinking and Drunkenness," to be presented at the annual meeting of the American Historical Association, in Chicago, 28 December 1984.

TITLE: Taverns and Popular Sociability in Eighteenth-Century Paris

INVESTIGATOR: Thomas E. Brennan, Assistant Professor, History Department

BACKGROUND: The tavern in pre-Revolutionary Paris was a theatre of several important facets of popular culture. Whether as an arena for violence and the expression of communal conflicts, a focus of friendship and solidarity, or an occasion for leisure and recreation, the tavern stood at the center of men's social existence. No other institution accommodated public discourse and comportment so well or so encouraged communal sociability. My study is an investigation of the culture of artisanal society, its structure and mentalities. I propose to show that the culture of the laboring classes especially as it was manifested in taverns, was a rational and legitimate expression of their sense of social values and needs.

Central to this study is the clash of elite and popular culture as it was articulated in the different reactions and attitudes to taverns. The elites saw in the tavern the very things that they feared and condemned in popular culture: indiscipline, lack of restraint and thrift, waste and effrontery, promiscuity and exuberance. Much of what they feared was actually happening, but their condemnation is a comment rather on the dissonance that existed between elite and increasingly capitalistic values, and the more traditional values of the poor. Elite attitudes stand in marked contrast to the perceptions expressed by the poor in their testimony and use of taverns. The disagreement is less about what happened in taverns than about the meaning of such behavior. My goal is to elucidate the logic and purpose of both systems of meaning and to return the dignity of coherence to the culture and values of the poor.

OBJECTIVES: I am preparing my manuscript for submission as a monograph and am presenting several parts of it as papers before scholarly meetings. Two sections of my work will soon be published as articles.

METHOD: Information about the illiterate, inarticulate masses in history comes inevitably from legal and fiscal records. I am looking at all such records that survive in Paris, particularly the extraordinarily rich archives of the police and criminal courts. I have collected sufficient material from these archives to attempt a quantified study of popular behavior. In addition I am examining the discourse surrounding popular culture and taverns, as it was expressed in literature, in royal and ecclesiastical pronouncements, and in testimony of the populace itself. While there is little fiscal evidence available on Paris, I am using the business records of wine merchants and tavern keepers.

RESULTS: My research on this project is essentially complete, and it remains only to be rewritten for publication. To that end, I spent the summer writing two new chapters which incorporate the fruits of new research from the two previous summers. These chapters address issues of general importance to eighteenth-century history, such as the nature of crime and violence among the working classes, the conception and defense of honor among the poor, and the functioning of an early example of the retail trade. Each of these topics give greater foundation to my discussion of taverns as a social institution. I have also been reworking the existing chapters, to include the vast quantity of new material that I have accumulated since they were first written.

TITLE: Modeling Navy Accessions and Reenlistment Behavior Using Pooled Cross-section and Time Series Data.

INVESTIGATOR: Associate Professor William R. Bowman, Economics Department

BACKGROUND: Much of the Navy personnel research is currently being undertaken at two research installations under DON contracting - Naval Personnel Research and Development Center and the Center for Naval Analyses. An attempt is being made to construct Navy military data sources at the Naval Academy to encourage more faculty and midshipmen research in this area.

OBJECTIVE: The N.A.R.C. grant was to be used to acquire alternative Navy manpower data bases and to transform these data bases into a usable format for faculty and midshipmen research at the Naval Academy.

METHODOLOGY AND RESULTS: Four separate data bases have been requested from the Defense Manpower Data Center (DMCD-Monterey, California) and the Naval Personnel Research and Development Center (NPRDC- San Diego, California). These data bases are:

1. Active Duty Master and Loss Edit File: Quarterly enlisted and officer files of demographic and military experience variables;
2. Military Reserve File: annual enlisted and officer files of military reserve experience variables;
3. V.A. Education and Training Benefits File: annual enlisted and officer files of Veterans' administration supported education and training; and
4. Post-Service Earnings History File: survey of eight year post-service civilian earnings of randomly selected group of enlisted and officer personnel.

The last file is operative on the Academy's computer system and was used to develop Navy enlisted post-service earnings profiles under contract with OP-126 of the Department of Navy this summer.

STATUS: Of the three data files described above, only the Post-Service Earnings History File is fully operative. It is now being analyzed and a final report will be completed by December, 1984. A copy of this report will be forwarded to the Committee upon completion.

PUBLICATIONS: Technical Report for OP-126 to be completed December, 1984.

PRESENTATIONS: Presentation on Navy Veteran Earnings Profiles to be delivered at Eastern Economic Association in March, 1985.

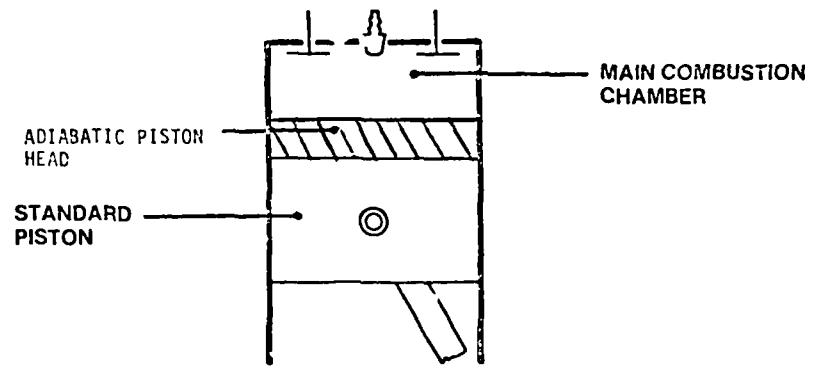


FIGURE I

TITLE: Evaluation of the Heat Transfer Characteristics of the Heat Barrier
Piston Engine

INVESTIGATOR: David A. Blank, LCDR, USN, Naval Systems Engineering Department

BACKGROUND: Investigation of the Controlled Heat Balanced Engine Cycle was begun in 1975 by Blaser. Current theoretical and experimental work point to the existence of internal regeneration within the engine cycle. The extent and time dependent nature of this regeneration is not well understood, though it is believed to be a large factor in increased engine efficiency. These and other factors have led to the need for an in-depth study of heat transfer within the engine. Preliminary work was performed by Professor Adams in 1977, by modeling the cap as a radial fin of constant thickness. Though the results of this study provided an initial base line for understanding the internal processes of the engine, the need has developed for follow-on work on an in-depth analytic nature.

OBJECTIVE: The present research aims at conducting a thorough analysis of heat transfer in the piston of a simplified model called the "adiabatic piston engine" (Figure I) by bringing to bear on the problems the array of recent developments in the areas of computational fluid flow, combustion, and radiation modeling. This particular engine was chosen for study not only because of the similarity between it and the heat balanced engine's piston heat transfer characteristics, but also because it shows tremendous promise in future engine applications. The ultimate intent of the analysis is a study of the mechanisms causing regeneration within the thermodynamic cycle of the engine in order to determine how to increase the overall engine efficiency of the adiabatic piston engine.

RESULTS: Investigation has resulted in the complete development of a model which very closely approximates the actual characteristics of the adiabatic piston engine (also called the heat barrier piston engine). Computer codes have been developed which model heat transfer, combustion, pressure and turbulent fluid motion within the combustion chamber and conduction heat transfer in the cylinder walls and piston of the engine. The code has been successfully subjected to a series of error analysis tests. The fluid motion portion of the code appears to correlate with the results of other researchers. The combustion model assumes hypergolic fuel conditions which places this code on the leading edge of engine combustion research. A comprehensive graphics package has been developed to analyze the data generated by the code. Included in this package is dynamic color coded presentation of temperature throughout the engine which will enable one to actually watch simulated heat flow through an engine cycle.

STATUS: Theoretical analysis has resulted in the completion of the model. With the exception of 3-D radiation all of the model has been programmed and the computer code is operative. The code is now being utilized to generate data for five basic engine configurations leading up to a final configuration with a fully operative valve and with combustion under hypergolic conditions.

PUBLICATIONS: None

PRESENTATIONS: None

TITLE: The Souls: High Society and Politics in Late Victorian Britain

INVESTIGATOR: Assistant Professor Nancy W. Ellenberger, History Department

BACKGROUND: "The Souls" is a study in the social history of the British upper classes at the end of Victoria's reign. The period was one of challenge for the traditional ruling class which had based its power and authority on land. Plutocratic families suddenly appeared in the highest circles of society, with an accompanying decay in the probity and refinement of aristocratic life. Sons of the middle classes, educated at public school and Oxbridge, usurped places in the civil service and the professions. Careers in politics came to require talents and concentration beyond the abilities of dilettante nobles. As Britain passed from a rural to an industrialized and urban society, the composition and functions of the ruling elites changed. Such transformations require decades to accomplish. In the years after 1885, however, they were clearly visible to any who had ambitions to social and political power at the national level.

The Souls had such ambitions. Led by Arthur Balfour, Margot Tennant, and George Curzon, the three dozen friends came mainly from the aristocracy, though a few representatives of newer commercial wealth leavened the mixture. After 1885, the group's distinctive tone brought the members notoriety and eventually prominence in the nation's highest social and political circles. When Balfour became prime minister in 1902, five of the Souls served in his government. My study examines the group within the context of the social and political changes affecting the aristocracy in the late 19th century. The manuscript begins with an analysis of the families of the Souls and describes the group's formation. The members' cultural pretensions are discussed, and their responses to intellectual and artistic controversies of the day. The lives of the women members are examined within the context of the "new woman" movement. A final group of chapters traces the Souls' political ambitions and the consolidation of their position among the country's political elite.

OBJECTIVE: I am preparing a manuscript on the Souls for publication as a book.

METHOD: "The Souls" is a contribution to the cultural, social and political history of Britain before World War I. Only recently have historians begun systematic study of the ruling classes in the modern period, despite much popular interest in anecdotes and personalities of the period. In the last two decades, however, monographs on aristocratic finance, the changing composition of political and professional elites, demography of the peerage, the influence of landowners on county politics and borough development have begun to appear. Such studies are beginning to elucidate, often in quantitative form, the major economic and social trends of the late Victorian era. All too often, these analyses and statistics neglect the impact of such changes on the private lives and personal outlooks of those who lived through them. My work is intended to fill this gap through the study of a particularly prominent, important and self-conscious group within the ruling circles. It is based on more than thirty manuscript collections, many of which are in the hands of the Souls' families and have not been used by scholars before. These diaries and letters give an unusual immediacy and reality to the

people and issues being investigated. When taken in combination with evidence from contemporary novels, press accounts, and social observers, the materials the Souls have left behind provide for a remarkably full group biography of an important section of Britain's ruling elite at the end of the nineteenth century.

RESULTS: In the summer of 1984 I spent two months at the U. S. Naval Academy, during which time I redrafted two chapters of the manuscript and wrote an additional section. The rest of the summer was spent on a four-week trip to England devoted to research. The papers of A. J. Balfour's private secretary, now at the Bodleian Library in Oxford, revealed much information on the politicians among the Souls, their relations with the prime minister, and their functioning within the cabinet. The Public Record Office's collection of the official correspondence of St. John Brodrick was similarly useful for the chapter on the political relations between these close personal friends. At the Brotherton Library, University of Leeds, I found many letters that members of the Souls had written to literary critic Edmund Gosse. Some of these were important for showing the group's tastes in reading and attitudes toward aesthetic and religious questions. Finally a number of collections in the British Museum - those of A. J. Balfour, G. B. Shaw, and Mary Gladstone Drew in particular - were consulted to supplement material for a chapter on the Souls at the end of their lives, after the group had lost much of its cohesion and purpose.

STATUS: My research among primary materials on the Souls is completed, and secondary and other published works that may be necessary for further rewriting are easily available in the Library of Congress. I am preparing within the next few weeks to show a draft of the manuscript to a publisher who has expressed interest in the project. Approximately a third of the manuscript is in final form and the rest will be redone with the publisher's advice. I am also working on two book reviews and an article on changes in London 'society' during the nineteenth century, to submit for publication within the next six months.

PUBLICATIONS: None

PRESENTATIONS: None

TITLE: An Investigation of Transition to Turbulence in Circular Cylinder
Boundary Layers

INVESTIGATOR: Assistant Professor Shirley T. Fleischmann, Mechanical Engineering
Department

BACKGROUND

Transition to turbulence in the circular cylinder boundary layer is accompanied by a significant decrease in the cylinder drag coefficient and by a cessation of strong periodic forces on the cylinder due to vortex shedding. Transition, which generally occurs over $4 \times 10^4 < Re_{Dt} < 5 \times 10^5$, is known to be affected by the roughness of the cylinder surface and by disturbances in the freestream. While transition is of obvious importance to the design engineer working with structures in flowing fluids near the transition region, there is to date no method by which the transition Reynolds number, Re_{Dt} , can be accurately predicted given the surface roughness and a knowledge about the freestream disturbances. Using experimental results from 2 independent studies it was found that:

$$Re_{Dt} Re_{Kt} = C \quad (1)$$

where D is the cylinder diameter, K is the roughness size and t denotes transition. This relation was experimentally verified in part I of this NARC research. The constant, C , appears to be unique to a given wind tunnel. Since freestream turbulence characteristics are also unique to a given wind tunnel it was proposed that the difference in C is due to differences in the freestream turbulence, and that it might be possible to formulate an overall constant which would include surface roughness and turbulence characteristics. Such a constant could be used to accurately predict transition to turbulence in circular cylinder boundary layers. If this experimental relation could then be explained theoretically, it might be possible to extend the prediction scheme to other shapes of interest.

OBJECTIVES:

1. To find the effect of freestream turbulence on transition and to explore the existence of an overall constant which includes the effects of surface roughness and turbulent disturbances in the freestream.
2. To justify the noted experimental result theoretically.
3. To develop new laboratory experiments using the equipment and methods used in this research. These experiments would be available for use in both Mechanical and Aerospace Engineering courses.

METHODOLOGY AND RESULTS:

In the literature on the effects of freestream turbulence on transition in circular cylinder boundary layers, the turbulence intensity, γ , is generally regarded as the most relevant turbulence parameter. The effect of increasing turbulence intensity is the same as that of increasing roughness; i.e. transition occurs at lower Reynolds numbers. For this reason it was first proposed that the turbulence intensity be included in an overall constant:

$$Re_{Dt} \cdot Re_{Kt} \gamma = \text{constant.} \quad (2)$$

While such a result was consistent with the two independent studies mentioned earlier, it was not found to be consistent with the results obtained in this project.

Motivated by the observation that hot wire signals in a flat plate boundary layer which is undergoing transition strongly resemble those for a beat phenomenon, it was proposed that the periodic freestream disturbances beat with the periodic disturbances introduced by flow over the rough surface. If the beat frequency is an unstable frequency for the laminar boundary layer transition will occur. Thus for transition to occur:

$$f_b = \frac{f_r - f_f}{2} \quad (3)$$

where $f_r \equiv$ roughness frequency, $f_f \equiv$ freestream frequency, $f_b \equiv$ unstable frequency for the laminar boundary layer found from a linear stability analysis.

The roughness frequency can be estimated by examining a mechanism whereby the surface introduces a periodic disturbance. As the fluid near the surface passes over it experiences alternate regions of high and low shear due to roughness (see figure 1). At low freestream speeds, U_∞ , the flow has adequate time to adjust to these changes. However, as the freestream velocity increases there will not be sufficient time for the upper fluid layers (above $y = k$) to adjust. In that case the alternate high and low shear acts as a periodic disturbance with a frequency:

$$f_r = \frac{U_L}{y} \quad (4)$$

Where U_L is the local velocity and y is the perpendicular distance from the surface. For the initial analysis this distance was estimated to be the roughness size, $y = k$. The flow is laminar before transition thus it is reasonable to assume a parabolic velocity profile; that is:

$$U_L = U_\infty \frac{y^2}{\delta^2} = U_\infty \frac{k^2}{\delta^2} \quad (5)$$

where δ is the boundary layer thickness. By noting that the laminar boundary layer thickness is inversely proportional to the square root of the Reynolds number it is possible to show that:

$$f_r = \frac{U_\infty k}{\delta^2} = (U_\infty k) C Re_D = C' Re_k Re_D \quad (6)$$

If the roughness frequency, f_r , can be shown to be constant over a wide Reynolds number range, then:

$$Re_{Dt} Re_{kt} = \text{constant} \quad (7)$$

From eqn. 3, the roughness frequency is:

$$f_r = 2f_b + f_f \quad (8)$$

Over the Reynolds number range that transition actually occurs it can be argued that f_b and f_f are constant. The unstable (beat) frequency for the

boundary layer is a property of the laminar profile. Over a limited range of Reynolds number it will be unchanged. The freestream disturbance frequencies are a result of ambient noise, blower characteristics, tunnel geometry, etc. Measurements made for this experiment showed that the freestream frequency spectrum changed only very slowly as tunnel speed increased. Thus the roughness frequency necessary for transition within a certain Reynolds number range is a constant.

Using an independent determination of unstable beat frequencies and an estimate for the boundary layer thickness at the flow separation point to find f_r , the expected freestream turbulence frequencies, f_f , for the experiment performed in part 1 of this research were found to be 886 hz, 777 hz and 583 hz for transition near 44 ft. Different f_f correspond to different roughnesses. For transition near 62 ft/sec a peak was expected at 5 khz.

A frequency analyzer was used to determine the frequency spectrum sensed by a hot wire anemometer which was placed in the unobstructed test section of the wind tunnel. Since transition was observed near 44 ft/sec and near 62 ft/sec frequency scans were obtained for those wind tunnel speeds.

RESULTS:

The frequency spectra measured in the wind tunnel at 44 ft/sec, and at 62 ft/sec = U_∞ are shown in Figure 2. The peaks near 886 hz, 777 hz, and 583 hz for $U_\infty = 44$ ft/sec, as well as the broad peak near 5 khz for $U_\infty = 62$ ft/sec are evident. The analysis is still preliminary in nature, however, there is sufficient proof that the general method for predicting transition may be valid. If so, then these results can be:

1. extended to prediction of transition around other shapes i.e. air foils
2. Used to estimate the observed differences between wind tunnel and full scale tests where system components are near transition.

STATUS:

- Objective 1: met
Objective 2: met
Objective 3: partially met. An experiment in which the students will measure the drag on a smooth circular cylinder with a laminar boundary layer by:
- a. integration of the measured pressure variation with angle
 - b. direct force measurement
 - c. survey of the wake velocity profile and a control volume analysis

will be used late in the fall, 1984 semester by EM324 students.

PUBLICATIONS:

1. A paper has been submitted to the Journal of Fluid Mechanics
2. A detailed Naval Academy technical report will be submitted

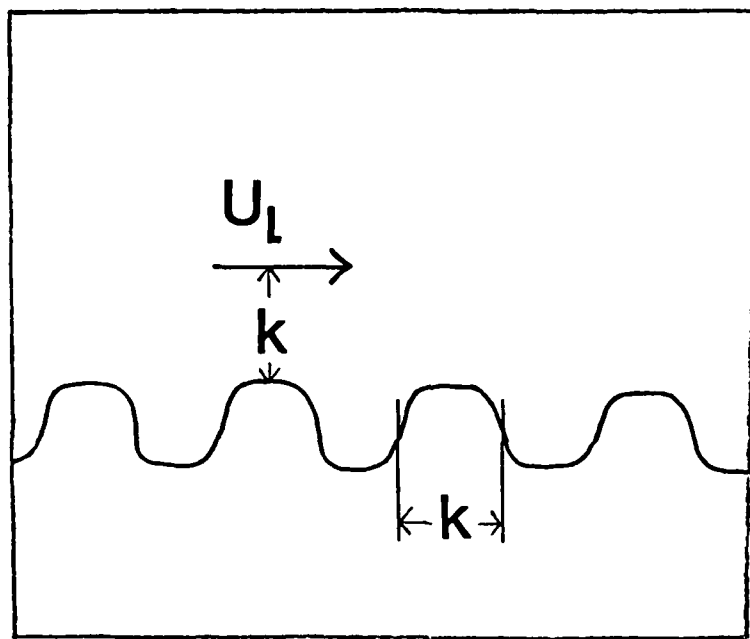
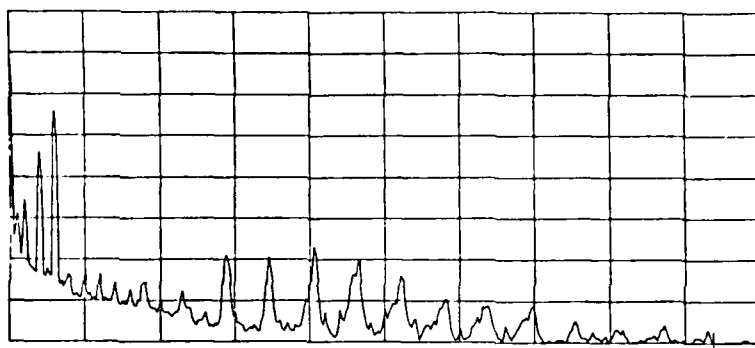
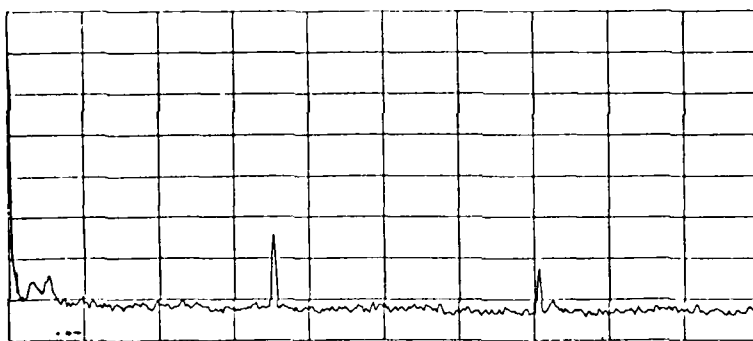


Figure 1. Flow near a uniformly rough surface where U_L is the local velocity at a distance k above the surface. ' k ' is the roughness size.



AVG=128
PWR SPECT A -100.6dBV 935.0 HZ N: 128 P: 2.5HZ
SPAN: 0.000000HZ-1.000000KHZ SN: -20dBV FS: - 20.00dBV 10dB/

a.



AVG=100
PWR SPECT A - 75.7dBV 1.00 KHZ N: 128 P: 250HZ
SPAN: 0.000000HZ-100.000KHZ SN: -10dBV FS: - 10.00dBV 10dB/

b.

- Figure 2a. Frequency scan for $U=44$ ft/sec. Note the peaks near 583 Hz, 777 Hz, and 886 Hz. The frequency scale spans 0-1 KHz with a linear scale of 100 Hz/div.
- 2b. Frequency scan for $U=62$ ft/sec. Note the peak at 5 KHz. The frequency scale spans 0-100 KHz with a scale of 10 KHz/div.

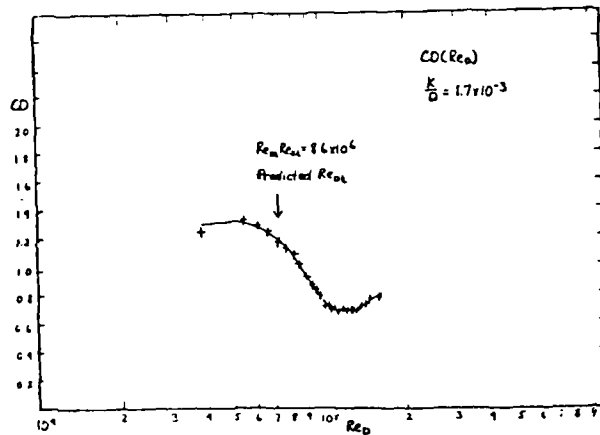
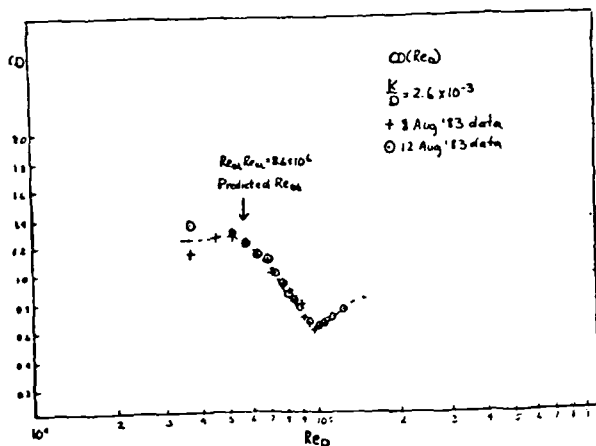
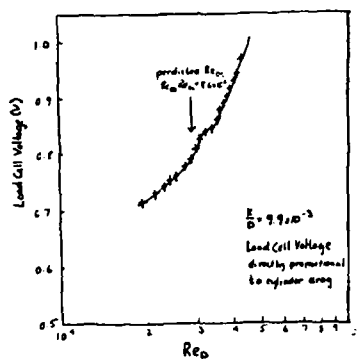
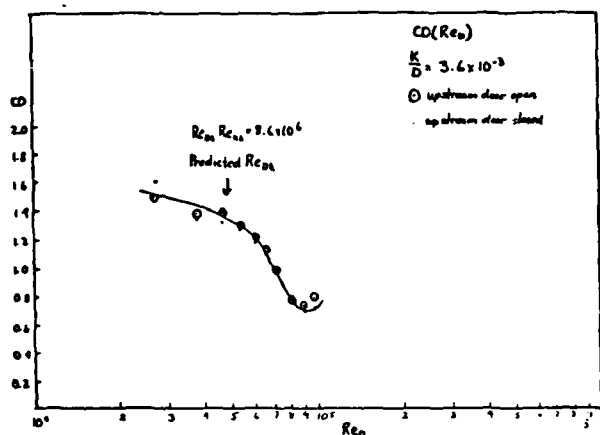


Figure 3. Results obtained in part 1 of this research. CD vs Re_D is shown for 3 relative roughnesses using a 3 inch diameter cylinder. Load cell voltage (directly proportional to drag) vs Re_D is shown for the 1 inch diameter cylinder.

TITLE: Self-Learning Methods in Optimal Control

INVESTIGATOR: Associate Professor Richard V. Houska, Ph.D,
Weapons and Systems Engineering Department

BACKGROUND: Optimal control is concerned with finding the best way of solving a control problem where "best" is defined in precise mathematical terms. There are many physical problems which can be solved effectively in a control theoretic context, although on the surface they do not appear to fit control theory models. An example is the "travelling salesman" problem where the shortest path connecting all cities in his territory must be found. There is no known method for solving this problem efficiently. However, recent research by the investigator has indicated that robust approximate solutions can be obtained from a stochastic control model, and that the approximations can be substantially improved through a self-learning or adaptive technique called backtracking.

OBJECTIVE: To investigate the optimizing structure of the backtracking technique as it is applied to the optimal control solution of certain minimum path problems in networks.

METHODOLOGY AND RESULTS: The investigation of this research problem was undertaken in the following steps:

1. Develop a digital computer program to implement the stochastic control algorithm and backtracking feature with graphical output.
2. Identify theoretical characteristics of the self-learning feature.
3. Develop a geometrical method for classifying networks.

The first step has been completed, and the digital program can be applied to almost any arbitrary network. On verifiable test cases the algorithm finds the exact (shortest path) solution 95% of the time. Computation time is of the order n squared. Steps 2 and 3 are in progress with no final or conclusive results to date. Work is continuing in these areas, and future support is being sought.

PUBLICATIONS: None.

PRESENTATIONS: A presentation paper is being prepared for the Fifth International Conference on Mathematical Modelling at UC Berkeley in August, 1985.

Title: Damage Development in Fiber - Reinforced Composite Materials

Investigator: Assistant Professor Russell D. Jamison, Mechanical Engineering Department

Background: Fiber-reinforced composite materials are becoming increasingly important in structures which require high strength and stiffness and low weight. The anisotropic, inhomogeneous nature of composite materials poses a number of important and interesting analytical and practical problems for potential users. In particular, there is not currently available a satisfactory model for predicting failure. This lack of fundamental understanding has slowed the development of critical, load-bearing structures for which composite materials are ideally suited and has resulted in very conservative designs in many cases. It has become clear in recent years that only by detailed, systematic examination of the way in which damage occurs during loading of composite laminates of various constituent fibers and resins can sufficient insight be developed to produce a general failure model for these complex materials.

Some results developed previously by the author and colleagues [reference 1] for laminates of graphite/epoxy subjected to tension fatigue loading suggested that failure was preceded by an interaction of distinct damage modes. Important details of this interaction were seen to occur at the micro-structural level i.e. on the scale of the individual fiber diameter ($\sim 7\mu\text{m}$). In the absence of companion damage development studies for the same laminates subjected to quasistatic tensile loading, the aspects of failure unique to fatigue loading could not be separated from those of graphite/epoxy generally. It was this lack of detailed damage assessment in tension loading of this and other fiber-reinforced systems which motivated the present research.

Objective: The major objective was to establish by direct experimental observation the modes and chronology of damage development in $[0,90_2]_s$ and $[0,0]_s$ laminates of graphite/epoxy and E-glass/epoxy material subjected to quasistatic tensile loading. This physical description of damage development would then be available for: (1) proper interpretation of previous fatigue results; (2) for gaining a better understanding of the tensile failure mechanism itself; and (3) in the case of the unidirectional $[0,0]_s$ laminates for assessment of several current micromechanical strength models.

Methodology and Results: Specimens of each laminate type were loaded to various specific fractions of the mean ultimate stress (\bar{S}_{ult}). Crack densities in the $[0,90_2]_s$ laminates were measured from edge replicas made under load and the crack density vs tensile load relationship was obtained (Figure 1). The 0 degree plies of these specimens were then "unstacked" from the rest of the laminate using the deply technique of Freeman [2]. In this method the damaged laminate is placed in a furnace and heated until the epoxy resin is partially pyrolyzed. The inter-laminar bond strength is thereby reduced sufficiently to permit ply from ply separation. When the plies are observed under an optical or scanning electron microscope, the state of fiber fracture is revealed. By determining the number of fiber breaks in randomly selected areas in the 0 degree plies of specimens representing the range of loading from 30-104% \bar{S}_{ult} , the relationship between fiber fracture density (broken fibers per mm) and tensile load (% \bar{S}_{ult}) was developed (Figure 2).

Two results of this research are potentially significant in the development of a general failure theory for composite materials. The first is Figure 2 itself. For although the general power law form of the relationship between fiber fracture density and tensile load has been hypothesized and has been inferred from other measurements (eg acoustic emission monitoring), the actual absolute relationship has not, to the author's knowledge, been established heretofore. This curve and a similar one for unidirectional graphite/epoxy laminates provides an experimental basis for evaluating various stochastic strength models currently in the literature. The second significant result of the work is the demonstration of the strong and perhaps dominant role of transverse ply cracks in producing and localizing fiber fractures in the adjacent load-bearing 0 degree plies. Fiber fractures in $[0,90_2]_s$ laminates were observed to occur in narrow bands outside of which there were nearly no fibers broken. The mean distance between these fiber fracture zones was found to correspond precisely to the measured spacing between cracks in adjacent plies. This localization of fiber fracture is counter to the random arrangement which would result if only the Weibull strength distribution of the fibers was considered, and which was in fact observed in the $[0,0]_s$ unidirectional specimens. This localized pattern is shown schematically in Figure 3. The coupling of ply cracks and fiber fracture may provide a framework for understanding the more subtle mechanisms of damage localization which are thought to precede laminate failure under both fatigue and static loading.

Status: The work on graphite/epoxy laminates is complete. The work on E-glass/epoxy laminates is not. Laminates of this latter material proved to be significantly more difficult to deply. By closely controlling the time and temperature and by using a locally-fabricated clamping fixture, a successful two stage procedure was developed. Collection of data for the load vs crack density and load vs fiber fracture density relationships for this material is currently in progress (October 1984).

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Publications

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Presentations

1. Jamison, R. D., "The Role of Microdamage in Tensile Failure of Graphite/Epoxy Laminates," International Symposium on Composites : Materials and Engineering, University of Delaware, September 24-28, 1984.
2. Jamison, R. D., "On the Interrelationship between Fiber Fracture and Ply Cracking in Graphite/Epoxy Laminates," ASTM Symposium on Composite Materials : Fatigue and Fracture, Dallas, October 24-25, 1984.

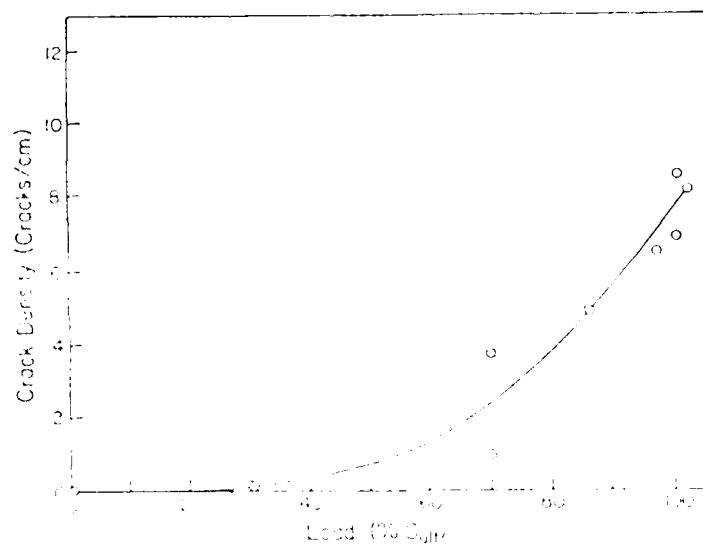


Figure 1. Crack density vs. load for (0.50) ϵ laminate.

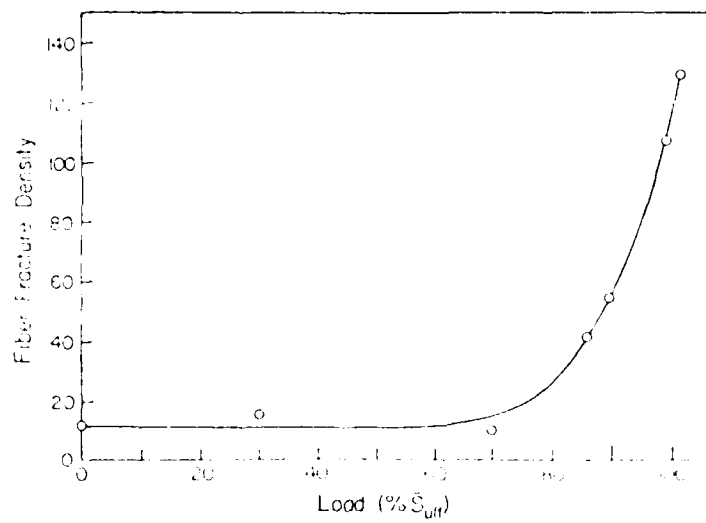
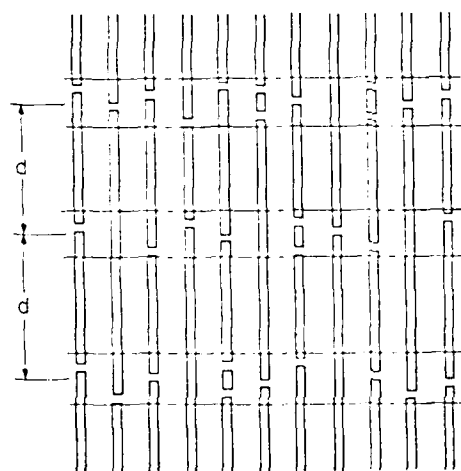


Figure 2. Fiber fracture density vs. load for (0.50) ϵ laminate.



d = ADJACENT PLY CRACK SPACING

Figure 3. Schematic drawing of fiber fracture pattern in a $[0, 90_2]_s$ laminate.

Title: Synthesis of Iridoid Monoterpenes that Mediate Insect Behavior

Investigator: Assistant Professor Tappey H. Jones
Chemistry Department

Background: The iridoid terpenes are, among other things, major components of the defensive secretions of a number of phytophagous beetle larvae. The natural materials have been shown to be extremely active as repellants in tests against such predators as fire ants, but they are available from natural sources only in minute quantities. In several cases, their molecular structures have never been rigorously confirmed by unambiguous synthesis. An iridoid terpene that has been of considerable interest is gyrinidone (1). This compound is the major component of the defensive secretion of a family of common "whirl-a-gig" water beetles that has the ability to stun predatory fish.

Objective: The objective of this research was and still is to develop a useful synthesis of gyrinidone, which would prove its structure and would provide samples for biological studies.

Methodology and Results: The key to any synthesis of gyrinidone is the establishment of the stereochemistry about the cyclopentane ring. Pugenolide (3) is an attractive precursor for gyrinidone because it has all of its cyclopentane substituents in the same configuration as gyrinidone. In addition, it can be prepared from commercially available, optically active pulegone (2) in a moderate yield. Since the optical activity of gyrinidone has been reported, a synthesis from pulegone would allow the absolute configuration of gyrinidone to be determined.

With this in mind, the following sequence was carried out. Pugenolide was prepared, and opened to the olefinic acid (4) with potassium *t*-butoxide. The carboxylic acid group was reduced and oxidized to give the aldehyde (5) which was immediately protected as its ethylene acetal (6). Pyridinium chlorochromate oxidation of the hydroboration product of 6 gave the aldehyde acetal (7). At this point, it was envisioned that 7 could be coupled to ethyl vinyl ketone in the presence of a thiazolium salt catalyst to give the ketone (8) which could be subsequently dehydrogenated and deprotected to give gyrinidone. Unfortunately, the thiazolium catalyst (A) proved to be ineffective in the coupling reaction, and although a less hindered catalyst was obtained, experiments with it have been inconclusive. It is hoped that a synthesis of gyrinidone from the aldehyde acetal 7 will be achieved in the coming year.

While the gyrinidone work was underway, a shipment of ants from Australia and a shipment of ants from New Zealand arrived at U.S.N.A.. Among these ants are samples of the genus Chelaner. The venoms of these Chelaner species were found to contain a variety of new alkaloids, among them the novel pyrrolizidine alkaloid 8. The structure of 8 was suggested by spectral studies, and confirmed by synthesis, although in low yield. This is the first time that allylic amines have been found in the venoms of ants other than those in the genera Solenopsis (Fire ants) and Monomorium (Pharaoh's ants.) In addition, Chelaner species from both New Zealand and Australia appear to contain other pyrrolizidines, whose structures have not been completely determined at this time. Finally, a novel set of pyrrolidines (9) and (10) were found in an Australian Monomorium species. Their structures were determined by mass spectroscopy coupled with sub-micro analytical techniques, and confirmed by synthesis.

TITLE: Cooper's Columbus in Mercedes of Castile

INVESTIGATOR: Robert D. Madison, Assistant Professor,
Department of English

BACKGROUND: Critics of American Literature have long dismissed James Fenimore Cooper's sea novel Mercedes of Castile as "sourcebound." Being sourcebound, however, does not determine the success or failure of narrative, as witness Melville's "Benito Cereno," for instance. The failure of Mercedes of Castile, if it is attributable to the novel's basis on historical events, must be the result not merely of the dependence on history, but on the manner in which history is incorporated.

OBJECTIVE: My immediate goal was to find out why or how Cooper could write a book which has been received so unfavorably at a time when he produced two of his best works, The Pathfinder and The Deerslayer. A larger goal was to study Cooper's process of composition in general--to study the methods he used or conventions he followed in writing the first commercially successful American novels. This knowledge in turn provides the foundation for the responsible editing of his works.

METHODOLOGY AND RESULTS: Through a comparison of the book and its written sources I examined the genesis of the book and its place in Nineteenth-century literature about Columbus. I found that Cooper felt he could not compete with Washington Irving's Life of Columbus in the narrative mode, and abandoned those modes of writing in which he himself excelled--narration and description--for a highly dramatic mode. Although the long dialogue had found its place in Pathfinder, it had not been used for the purpose of transferring historical fact, as it is used in Mercedes. Mercedes, then, is essentially an experiment in fiction, albeit an unsuccessful one.

STATUS: The project is complete.

DISSEMINATION: An article detailing my research and conclusions is being published as part of the proceedings of the seminar named below.

PRESENTATION: A lecture based on my research and illustrating my conclusions was presented at SUNY/Oneonta as part of the seminar "James Fenimore Cooper: His Country and His Art" in July 1984.

The detection of radiation at subharmonics ($f_{s1} = f_1/2$, $f_{s2} = f_2/2$, $3f_{s1}$, $3f_{s2}$) shows evidence of small air bubbles in the turbulent flow.

STATUS: The crossed beam and single beam scattering experiments have been completed. The stored data is currently being analyzed at NRL. Preliminary results on the nonlinearly scattered pulses reveal some detailed information involving the intricate mechanisms that govern the scattering of sound by the turbulence. These results combined with single beam scattering will be used to characterize the turbulent flow field.

PUBLICATIONS:

- (a) "Scattering from Crossed Ultrasonic Beams in the Presence of Turbulence," J. Acoust. Soc. Am. 71, S30(A) (1982).
- (b) "Experimental Investigation of Nonlinear Crossed Beam Scattering in the Presence of Turbulence," J. Acoust. Soc. Am. 74 S48(A) (1983).
- (c) "Enhancement of the Nonlinear Scattering of Crossed Sound Beams in the Presence of Turbulence due to a Concentration of Bubbles in the Interaction Region," J. Acoust. Soc. Am. 76, S(30) (1984).

PRESENTATIONS:

Invited colloquium speaker at the Acoustics Division of NRL, Washington, DC, May 1984. The presentation was entitled: "Scattering from Crossed Ultrasonic Beams in the Presence of Turbulence," Washington, D.C.

TITLE: Nonlinear Scattering of Crossed Sound Beams in the Presence of Turbulence and Bubbles

INVESTIGATOR: Assistant Professor Murray S. Korman, Physics Department

BACKGROUND: Acoustic measurements from the scattering of a monochromatic continuous wave beam of sound incident on a turbulent flow can be used to characterize the flow field. Measurements of the Doppler shift, f_d , are useful in predicting the mean flow speed, V_0 , while measurements of the spectral broadening, Δf_e , determine the average velocity fluctuations $\sqrt{\overline{u'^2}}$ across the interaction region. The scattering cross-section $d\sigma/d\Omega$ measured as a function of angle θ is used to determine the energy spectral density $E(k)$ of the statistical wavenumber components k corresponding to the turbulent eddies. Other acoustic measurements involving the probability density fluctuations of the scattered intensity are related to the probability density function PDF of the velocity fluctuations of the turbulence.

The equations relating acoustic scattering phenomenon in terms of quantities that characterize the turbulent flow can be obtained to reasonable accuracy by using a scattering model (developed by the author) that utilizes some results by Kraichnan and Ishimaru. However, the results are only good in the Born approximation. Here the scattering volume is restricted to be so small that sound waves can only scatter once from the interaction region. Accuracy is extremely limited in the case of sound scattering from large volumes - i.e. multiple scattering.

OBJECTIVE: The nonlinear interaction of mutually perpendicular crossed sound beams ($f_1=2.1$, $f_2=1.9$ MHz) interacting in the presence of turbulence in water shows that a radiated sum frequency component ($f=4.0$ MHz) is detected (outside the interaction region) in the presence of turbulence. In the absence of turbulence virtually no sound is detected (outside the interaction region). The overlap of the crossed beams with the turbulence provides an extremely small interaction region in comparison with a single beam geometry. Therefore, nonlinear crossed beam scattering measurements at the sum frequency component should provide more spatial resolution than the conventional single beam measurements.

Scattering experiments performed at the sum frequency are compared with the author's nonlinear scattering model in an effort to determine the characteristic flow parameters of a submerged water jet. Comparisons are made with the single beam scattering geometry.

METHODOLOGY AND RESULTS: The USNA Hydrodynamics Tow Tank Facility was used to perform the crossed beam scattering experiments in the presence of turbulence. Aluminum structures supported the pulsed ultrasonic sending and receiving transducers. A 5 HP centrifugal water pump was connected to a $\frac{2}{10}$ inch diameter submerged water jet. Scattering measurements were taken at 10° increments for a full 360° rotation of the crossed beam apparatus. Signal processing was performed on a Norland 3001 digital oscilloscope.

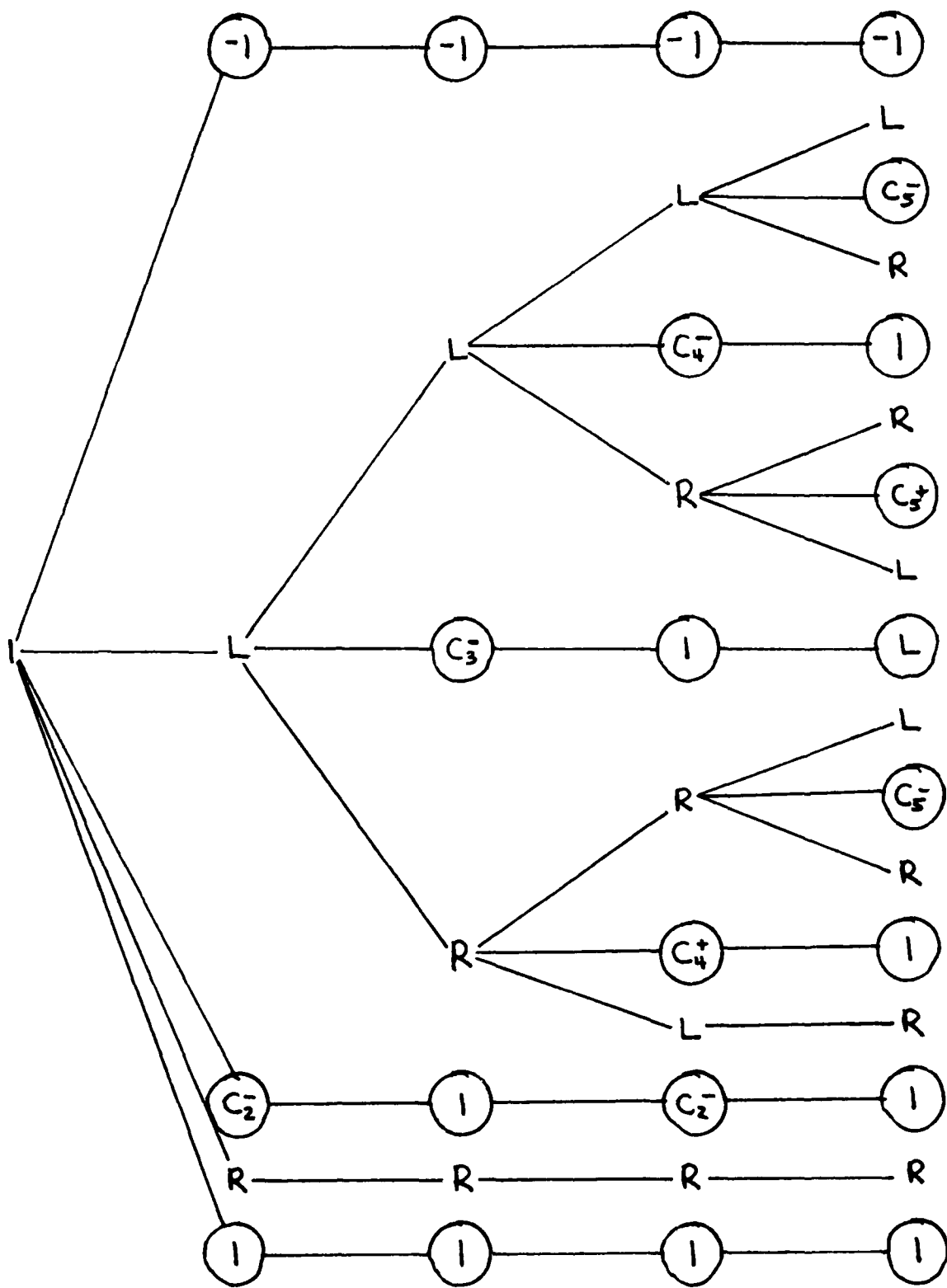


FIGURE 3

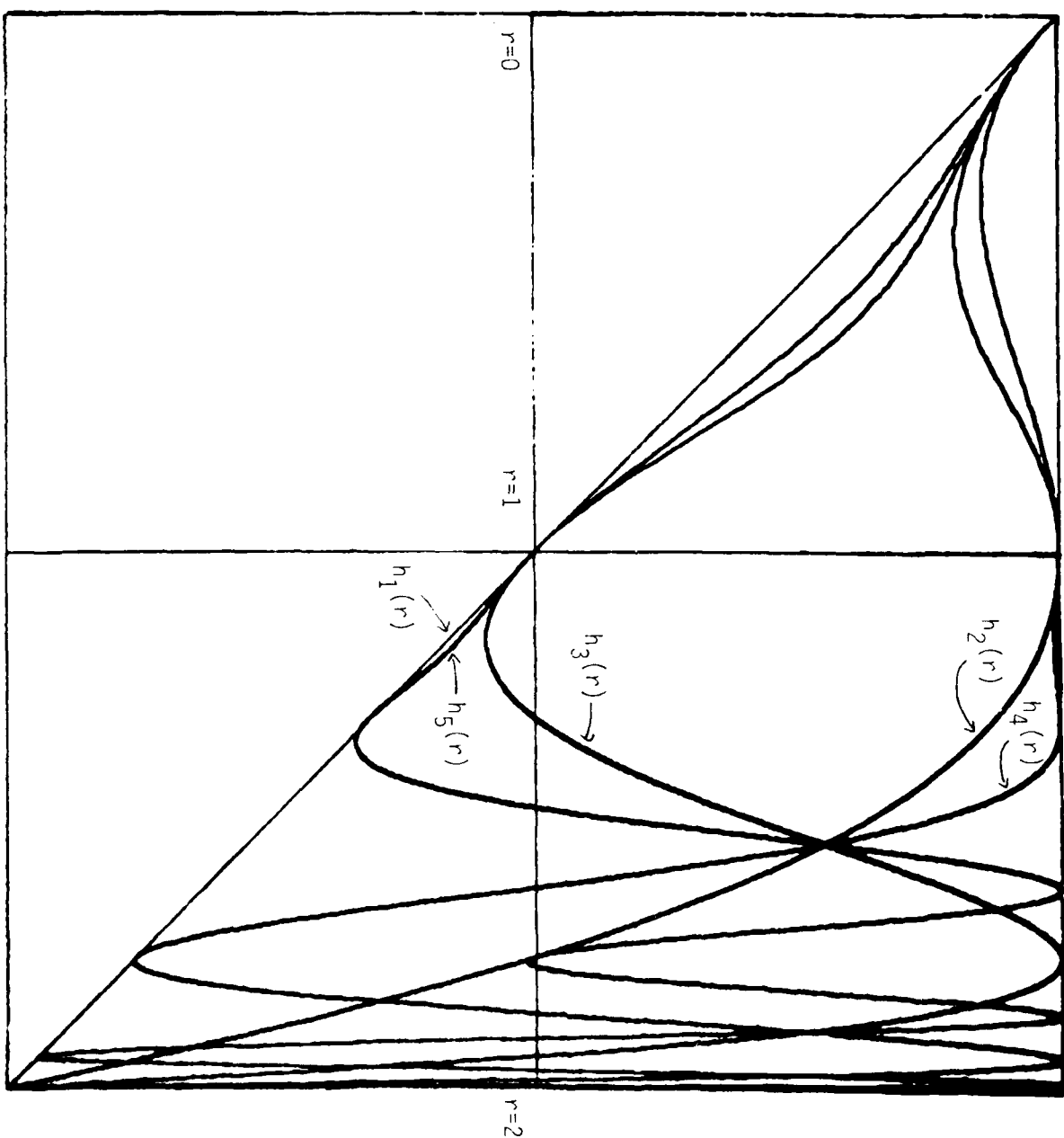
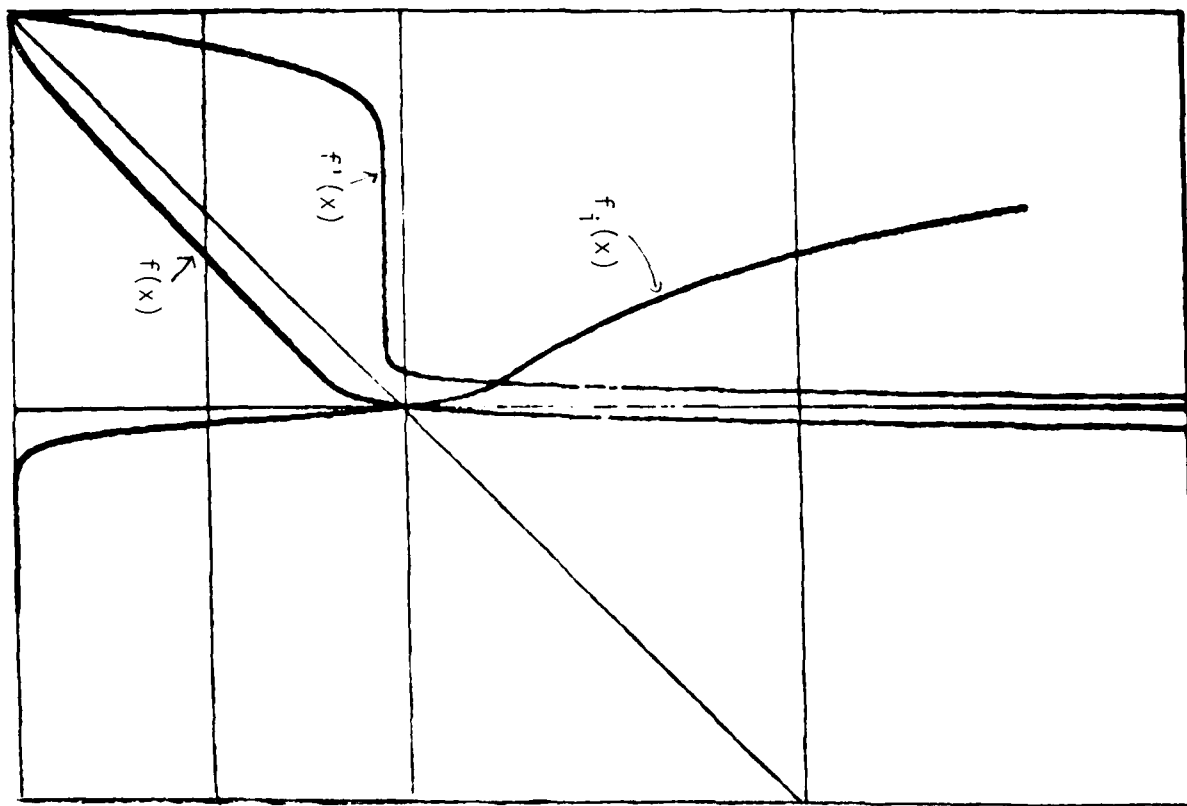


FIGURE 2



Although the smooth rules give the simplest possible behavior of a family of differentiable functions, they are maximal in another sense. Any violation of the smooth rules would mean that the same kneading sequence appears for disconnected r -values. On the evidence of computer graphics, I now believe that this "monotonicity" condition has counterexamples.

In an unrelated development, Professor Craig Bailey and I continued our work on special types of Hamiltonian circuits in planar graphs. This led to the paper listed below.

STATUS: My search for a function which violates monotonicity has reached a critical stage. After spending the last month of the summer getting computer programs to run and searching for plausible functions, I now believe that I have found such a function. If I am correct, I will write a paper (and probably also an A.M.S Abstract) devoted exclusively to the example. With this example in mind, I will rewrite all of my work of the last two years on rooted trees.

PUBLICATIONS: With C. Bailey, "A King's tour of the chessboard," submitted for publication.

PRESENTATIONS: "Iteration of unimodal maps of the interval: a rooted trees approach", University of Maryland seminar, August 1984.
"Introduction to dynamical systems," first three weeks of new faculty seminar, USMA, August & September, 1984.

		$h_{n+1}(r_2)$			
		L	C-	C+	R
$h_{n+1}(r_1)$	L	L	R C+ L	L	R C+ L
	C-	L	R C+ L	L	R C+ L
	C+	L C- R	R	L C- R	R
	R	L C- R	R	L C- R	R

The middle of the chart represents the simplest possible behavior of $h_{n+1}(r)$ on $[r_1, r_2]$ consistent with the intermediate value theorem and the assumption that $h_{n+1}(r)$ is a differentiable function. For example, if $h_{n+1}(r_1) > 0$ (R) and $h_{n+1}(r_2) < 0$ (L), then we assume that there is one point $r' \in [r_1, r_2]$ such that $h_{n+1}(r) > 0$ for $r \in [r_1, r')$, $h_{n+1}(r') = 0$ and $h_{n+1}(r) < 0$ for $r \in (r', r_2]$. We call the model embodied by this chart the "smooth rules".

The predictions of the smooth rules can be conveniently represented by a rooted tree, in which the nodes of the n th generation represent the behavior of $h_n(r)$. Circled nodes represent specific values of r in the partition P_n , and uncircled nodes represent the intervening open intervals. Circled nodes will have exactly one descendant in each generation, since their entire history must be cyclic. The branching of uncircled vertices is given by the smooth rules. The "smooth tree" shown in Figure 3 may be compared with the actual behavior of the $h_n(r)$ shown in Figure 1. This tree can be shown to have self-similarity properties that have actually been observed as "period doubling bifurcation" in families of functions.

represents kneading $(n + 1)$ -cycles: that is, $1 = f_r(0)$, $f_r(1) = f_r^2(0)$, ... , $f_r^n(1) = h_n(r) = f_r^{n+1}(0) = 0$. At such an r -value, the values of h_{n+k} are determined for all k : they must follow the cyclic pattern already established.

Thus for each n , the r -interval $[0,2]$ has a partition P_n consisting of subintervals whose endpoints are all points r such that $h_k(r) = 0$ for some $k \leq n$. These partitions become finer as n increases.

OBJECTIVE: During 1983, I formulated a set of "minimal rules" which generate a rooted tree whose n th generation is a possible model for the above partition P_n . The family of functions is only assumed to be continuous, and only those cycles required by the intermediate value theorem are predicted to exist.

During 1984, I have made the necessary modifications to study kneading cycles of differentiable functions. The minimal rules are replaced by the more detailed "smooth rules" given below. These generate a "smooth tree" which contains the minimal tree as a subtree. The smooth tree has interesting self-similarity properties. Any differentiable function which does not follow the model given by the smooth rules cannot satisfy the monotonicity property given below.

METHODOLOGY AND RESULTS: Let f_r be a family of differentiable, unimodal functions as given in the BACKGROUND section. Given all the kneading k -cycles of f_r , $k \leq n$, I have developed a model for the placement of kneading $(n+1)$ -cycles. Let r_1 and r_2 be two consecutive r -values in the partition P_n . Then $h_{n+1}(r_1)$ and $h_{n+1}(r_2)$ are already determined, and these values can be converted to L, C-, C+ and R. (C- and C+ distinguish the cases where h_{n+1} is decreasing or increasing at r_i). There are thus 16 possibilities for $h_{n+1}(r_1)$ and $h_{n+1}(r_2)$, which can be represented in a chart as follows:

TITLE: Dynamical and Combinatorial Properties of Maps of the Interval

INVESTIGATOR: Assistant Professor Mark E. Kidwell, Mathematics Department

BACKGROUND: A continuous function f_r on $[-1, 1]$ is called unimodal if it is monotonically increasing on $[-1, 0]$ and monotonically decreasing on $[0, 1]$. A point x is on a cycle if $f_r \circ f_r \dots \circ f_r(x) = x$ for some number of iterates of the function f . Much can be learned about a unimodal function by determining whether the iterates $x, f(x), f \circ f(x), \dots$, lie in the left-hand interval $[-1, 0]$ (denoted L), the right-hand interval $(0, 1]$ (denoted R) or the center point 0 (denoted C). A sequence such as $R L L C R \dots$ describing the location of x and its iterates is called the itinerary of x . The itinerary of 0 is called the kneading sequence of f . If 0 is part of a cycle, its itinerary is called the kneading cycle of f .

This year's work has mainly been devoted to families of unimodal maps of the form $f_r(x) = F(r, x) = 1 - r f(x)$, $0 \leq r \leq 2$, where f is a differentiable function with $f(\pm 1) = 1$, $f(0) = f'(0) = 0$ and $f''(x) > 0$. Thus when $r = 0$, $f_r(x)$ is constantly 1 , but when $r = 2$, f_r maps onto the interval $[-1, 1]$ in a 2-to-1 fashion. As a general rule, f_r develops a more complicated cycle structure as r increases.

We are particularly interested in how the kneading sequence changes as r increases. It is useful to have a sequence of functions in the r -domain to keep track of this. We define $h_0(r) = f_r(0) = 1$, $h_1(r) = f_r \circ f_r(0) = f_r(1)$, $h_2(r) = f_r \circ f_r(1)$, etc. We can define the $\{h_n(r)\}$ inductively by $h_0(r) = 1$, $h_n(r) = F(r, h_{n-1}(r))$. Computer plots of the graphs of $h_n(r)$, $n = 0$ to 5 , for the functions $F(r, x) = 1 - r x^2$ are shown in Figure 2. The places where $h_n(r) = 0$

Samples containing additives for the purpose of increasing viscosity and lifetime in water were prepared by adding the previously compounded liquid crystal (LC) described above to a solution containing the additive. The homogeneous solution was concentrated in vacuo and the final traces of solvent removed at high vacuum. The resultant, highly viscous solutions were painted on the ship model using a small paint brush. The ship model for these tests was a wing-shaped strut mounted in the twelve-inch water tunnel at NSRDC, Carderock. LC containing numerous additives were tested in this fashion and the results recorded on videotape and by still photography. As a result of these tests several generalizations concerning the effects of additives could be made: (1) long chain aliphatic esters of either glycerol or aliphatic alcohols do not inhibit color response and tend to increase longevity in water; (2) long chain aliphatic alcohols neither impair LC response nor add to the lifetime of the LC in water; (3) increasing the concentration of long chain aliphatic did not appreciably alter longevity of LC response; (4) mixtures of (1) and (2) oddly, showed reduced ability to respond to shear stress; (5) nonpolar organic soluble polymers inhibit response; (6) polar organic soluble polymers seem to enhance LC response but decrease the lifetime of the sample in water. A final test of pure LC mixture applied by atomization of an ether solution to yield a thin film demonstrated that shear stress occurs on thin films without movement of the LC. Thus, all color changes are due to variations in shear, not flow of the sample, and are not artifacts of the film thickness. From the model tests the following hydrodynamic phenomena could be observed showing up as various hues of green and yellow and, occasionally, blue. At the leading edge of the strut where laminar flow occurs, generally a light green or green color is visible. In the transition region, where flow changes from laminar to turbulent, a region that appeared almost white was seen. Superposed on this were flashes of blue that reversibly moved out of the transition region into the region of laminar flow. Beyond the transition region the conversion to turbulence was complete, seen as a dark green. A final line parallel to the trailing edge was green, indicative of reduced shear.

STATUS: The results of these demonstrate that LC thin films containing additives or atomized films of LC show clearly the hydrodynamic variance in shear manifested by different colors. It is now possible in practice to clearly locate the transition on ship models experimentally, and the colors could be calibrated to quantify the relationship between the color of reflected light and the shear stress. It is clear that future investigations of thin films and atomized films should be made to refine the color response. Additional possible applications to propellar design and perhaps aerodynamics are likely fruitful avenues for future study.

PUBLICATIONS: Technical report in preparation.

PRESENTATIONS: None to date.

TITLE: Liquid Crystal Visualization of Hydrodynamic Flow

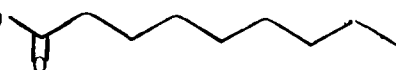
INVESTIGATOR: Taylor B. Jones, Ph.D., Assistant Professor, Chemistry Department

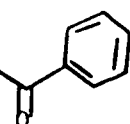
BACKGROUND: Measurement of shear stress, the resistance of a vessel to water as it moves past the surface of the vessel, for the purpose of improving hull form design of Navy ships has to date largely consisted of isolated measurement achieved by tedious and costly installation of pressure gauges flush with the surface of a ship model. The immediate advantages of a general method applicable to large areas that would afford either a qualitative or quantitative determination of shear stress are obvious: hull form design could be tailored to maximize fuel efficiency, improve maximum speed, and the effects of design alternation on ship performance would be determined quickly and inexpensively. Pressure sensitive liquid crystals were thought to be potentially ideal candidates to visualize hydrodynamic flow on surfaces.

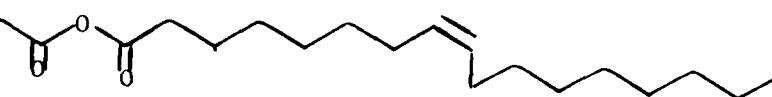
OBJECTIVE: The objective of this project was to investigate whether liquid crystal mixtures either neat or containing additives would respond to varying shear stress under conditions of hydrodynamic flow in an optically detectable fashion. Important criteria were color response in the pressure ranges that occur at water velocities of zero to twelve knots, the longevity of the liquid crystal in the water, and possible water pollution problems from loss of liquid crystal from the surface of the ship model.

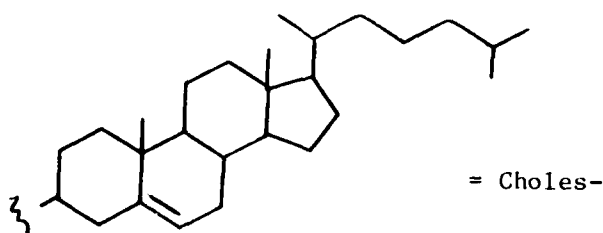
METHODOLOGY: Previously reported liquid crystal mixtures that demonstrated shear stress response consist of derivatives of cholesterol (Choles-). In particular, one liquid crystal mixture which is relatively temperature insensitive and for which quantitative shear stress data are available consists of the following components and their relative percentages by weight:

60% CholesCl

30% CholesO 

5% CholesO 

5% CholesO 



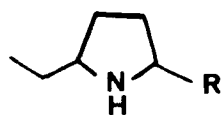
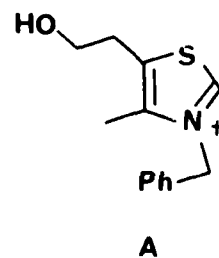
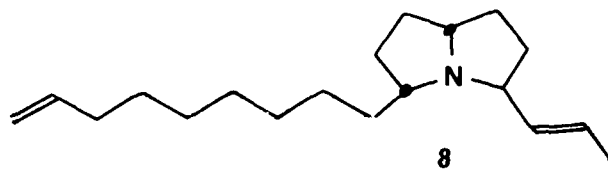
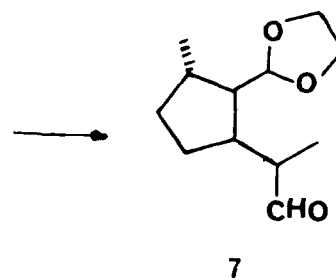
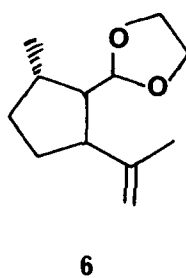
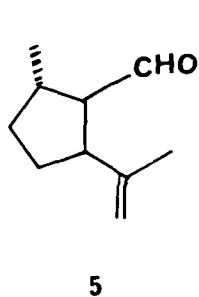
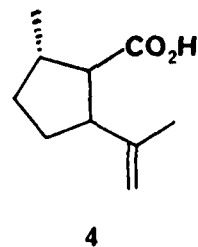
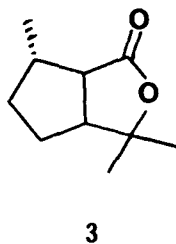
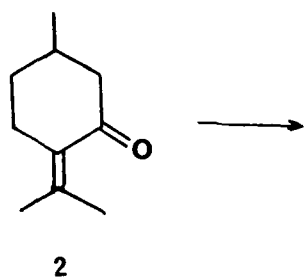
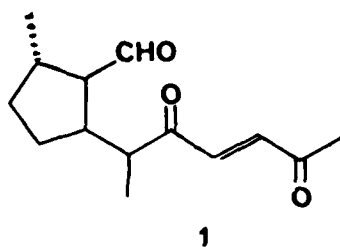
Status: A fairly large quantity of the acetal 6 has been accumulated. This material has the possibility of being carried on to gyrinidone by a number of different routes. The research on ant venom alkaloids is also being pursued.

Publications:

1. H.M. Fales, M.S. Blum, Z. Bain, T.H. Jones, and A.W. Don, "Aliphatic Amines from the Ponerine Ants of the Genus Mesoponera", J. Chem. Ecol., 10, 651 (1984).
2. Z. Bain, H.M. Fales, M.S. Blum, T.H. Jones, L.E. Rinderer, and D.E. Howard, "Chemistry of the Cephalic Secretion of the Fire Bee Trigona (Oxytrigona) rufata," J. Chem. Ecol., 10, 451 (1984).
3. T.H. Jones, R.L. Hight, M.S. Blum, and H.M. Fales, "(5Z, 9Z)-3-Alkyl-5-methylindolizidines from Solenopsis (Diplocephoptrum) Species," J. Chem. Ecol., 10, 1233 (1984).

Presentations:

1. I presented an invited poster session - "Indolizidine Ant Venom Alkaloids" at a National Institute Conference on Molecular Messengers in Nature, Nov.-Dec. 1983, in Bethesda, MD.
2. I presented an invited paper - "Synthesis for the Structure Proof of Ant Venom Alkaloids" at a symposium on The Latest Trends in Organic Synthesis, Dec. 11-16, 1983, at NPLA, Boulder, CO.



TITLE: The Stability and Asymptotic Behavior of Solutions of a Thermo-elastic Shell

INVESTIGATOR: Assistant Professor Reza Malek-Madani, Mathematics Department

BACKGROUND: A central and fundamental problem in the mathematical theory of continuum mechanics concerns the smoothness of solutions of the governing equations. As the mathematical models considered become more elaborate and realistic the questions related to the existence and regularity of the solutions become equally as complex. It is well known, for example, that continuous solutions to the equations of nonlinear elasticity develop singularities (shocks, cavities, fracture) for a rather large class of initial data, no matter how smooth and small the initial functions are. In this proposal we investigate the effect of heat transfer on the formation of such singularities for a class of incompressible isotropic hyperelastic materials. More specifically, we develop the equations of motion of an incompressible thermoelastic shell subject to compatible initial and boundary conditions. The thermo-kinetic constraint of incompressibility, which takes into account the change in temperature, is

$$(1) \quad \det B = g(\theta)$$

where $B = FF^T$, $F = \nabla u$ is the deformation gradient and θ denotes the temperature (cf. Alts [1] for details). We then prove a local existence and uniqueness theorem for all initial data which belong to a suitable Sobolev space.

Moreover, it is observed that the life span of these solutions depend inversely on the Sobolev norm of the initial data. This result suggests that the dissipation due to heat conduction may not be strong enough to ensure global existence of solutions of problems which are genuinely three dimensional. This is in marked contrast to the results of C. M. Dafermos [2] who obtained global existence of solutions for the equations of motion of one dimensional thermoelastic materials.

Objective: Upon establishing the local existence and uniqueness of solutions in the appropriate function class, our objective becomes the study of global properties of solutions, in particular, classifying the initial data for which the solutions are bounded and exist for all time. Moreover, the thermo-kinetic constraint (1) used in this investigation does not take into account all the experimental evidence concerning the rubberlike region of polymers. As pointed out by Treloar [3], when an adiabatic extension is applied to rubber the temperature increases with elongation except that for long elongations there is a temperature drop. To account for such a phenomenon it seems appropriate to replace (1) by an equation of the form

$$(2) \quad \lambda_1 \lambda_2 \lambda_3 = g(\theta, \lambda_1, \lambda_2, \lambda_3)$$

when λ_i are the eigenvalues of B . As a part of a future project a numerical study of the equations of motion together with (2) should be performed to ascertain the applicability of our model.

Methodology and Results: The equations of motion together with (1) form a mixed system of parabolic-hyperbolic partial differential equations. In order to prove local existence and uniqueness of solutions I used an energy method which combines standard parabolic a priori estimates together with the characteristic method which the system inherits from its hyperbolicity. This method has been successfully used by Dafermos [2] to prove global existence in the particular problem he considered, however we are not able to obtain as strong a result since our problem is in a three dimensional setting as opposed to only one dimension considered in [2]. To obtain solutions which become singular in finite time I propose to study the growth of the L^2 norms of the solution and its first derivatives by obtaining differential inequalities for those norms from the governing equations. This idea has been particularly successful in problems where the nonlinearity due to the stress is large enough to suppress any smoothing effects due to the parabolic nature of the problem.

Status: The theorem on local existence and uniqueness of solutions has been proved and is being prepared for publication. In addition, some of the work on the question of classifying the initial data for which global existence of solutions fails has been accomplished. Further investigation is required to determine the necessary and sufficient conditions on the initial data for the global existence of smooth solutions.

References:

- [1] Alts, T., "On the energy-elasticity of rubberlike materials", Progr. Colloid & Polymer Sci. 66, 367-379 (1979).
- [2] Dafermos, C. M., "Dissipation Stabilization and the Second Law of Thermodynamics", Lecture Notes of the University of Padua, 1982.
- [3] Treloar, L. R. G., "The Physics of Rubber Plasticity", Clarendon Press, Oxford, England, 1975.

Publications: A paper on the details of the existence and uniqueness theorem is in preparation.

Presentations: I am invited to present these results in the special session on hyperbolic partial differential equation of the annual meeting of the American Mathematical Society, 9-13 Jan 1985.

TITLE: Measure and Decision Theoretic Foundations of Metric Multidimensional Scaling

INVESTIGATOR: Assistant Professor Robert L. Manicke, Mathematics Department

BACKGROUND:

Pattern recognition can be defined as the categorization of input data into identifiable classes via the extraction of significant features or attributes of the data from an original background containing irrelevant detail. Human recognition of patterns may be considered as a psychophysiological problem which involves relationships between a person and physical stimuli. When a person perceives a pattern, he/she makes an inductive inference and associates this perception with some general concepts or cues which are derived from past experience. Human recognition is in reality a question of estimating the relative odds that the input data can be associated with one of a set of known statistical populations which depend on past experience and which form the criteria and the a priori information for pattern recognition. Thus, the general problem of pattern recognition may be regarded as one of discriminating among the input data, not between individual patterns but between statistical populations, via the search for features or invariant attributes among members of populations.

The field of pattern recognition can be logically divided into two categories:

1. The analysis of pattern recognition by humans.
2. The development of the methodology and theory for the design of devices and techniques capable of performing a given recognition task for a specific application. In the theory and computing machines associated with the field of artificial intelligence the findings and principles embodied in 1. have been the foundation models for 2. Regardless of the type of problem, the general classical model of pattern recognition involves three operations: representations, feature extraction, and classification.

The feature extraction stage is highly problem dependent and in many cases is not described mathematically. Because of the non-mathematical nature of the feature extraction stage there is a tendency for practitioners of pattern recognition in different disciplines not to communicate. In many specific applications of pattern recognition such as neurobiological signal processing, image processing, artificial intelligence and sonar detection it is the authors viewpoint that analyzes of these types of problems require a general underlying set of foundational theory. Moreover, in each of these applications the original input state vectors are assumed to be represented by a vector on an n -dimensional Euclidean space, when in fact there does not exist any theoretical or empirical justification for this assumption.

METHODOLOGY AND RESULTS: The investigator has succeeded in showing for certain types of data that classes of Riemmanian manifolds are "admissible" state spaces. Furthermore, the investigator exhibits a practical technique (2,3) to extract features from an admissible state space.

STATUS: Many foundational results have been demonstrated. The investigator is considering new concepts in the applications of these results, particularly in the area of sonar feature extraction and classification. Work is progressing on the general probabilistic geometrical foundations of feature extraction in classical pattern recognition. The investigator has been invited to present this research at the second meeting of the International Association of Pattern Recognition special session on practical techniques, June 1985, Amsterdam.

In Manicke (1) the author develops foundational structure based on the theory of monotonic metric transformations to show when a feature extraction modelling space needs to be more general than an ambient Euclidean space and metric. This paper gives, in general, heuristic validation for modelling with a variable point metric, and for certain types of problems specific validation of the Riemann metric and manifold. Furthermore, the author develops statistical admissibility criteria for the validity of any random metric and ambient modelling space for pattern recognition feature extraction. Explicit in this research is a general foundational system for feature extraction that will guarantee a random modelling space. For fixed known metrics a technique is developed that simultaneously chooses both points and paths randomly.

Since paths (of minimum length) on manifolds are geodesics and every geodesic can be characterized by a system of second-order ordinary differential equations, Manicke (2) gives conditions that will guarantee unique solutions to these systems written with boundary values. Based on the results of 2. Manicke (3) is developing a technique to model patterns on pre-specified manifolds in which distance is characterized by geodesics between admissible point sets.

The author has developed and is continuing to develop probabilistic foundations of the general pattern recognition model (4). Theory has been developed to model state spaces for the feature extraction stage. Evidence and derivations are exhibited to associate probability structures with random metric spaces.

PUBLICATIONS

1. R. L. Manicke, "On the Topological and Measure Theoretic Foundations of Metric Multidimensional Scaling", accepted and to appear in the Journal of Mathematical Social Science (Ki Whang Kim, editor), March 1985, Vol. 1.
2. R. L. Manicke, "Unique Solutions of Systems of Second-Order, Nonlinear, Two-Point, Boundary-Value Problems", Journal of Computation and Applied Mathematics, Vol. 10, pp. 175-179, 1984.
3. R. L. Manicke, "Object Identification from Point Set Tensors - A Stochastic Geometrical Analysis", in progress (tentatively accepted) and to appear in the Journal of Pattern Recognition.
4. R. L. Manicke, "Stochastic Geometrical Foundations of Metric Multidimensional Scaling", requested by a committee of the International Association of Pattern Recognition for a special edition of the Pattern Recognition Journal, June 1985.

PRESENTATIONS:

Presented initial version of (3.) at the International Conference on Pattern Recognition.

TITLE: Applications of Stochastic Estimation and Control Theory

INVESTIGATOR: Assistant Professor Paul B. Massell
Mathematics Department

BACKGROUND AND OBJECTIVE:

One of the most interesting discoveries in mathematics in recent years was that systems of difference or differential equations can have totally ergodic (chaotic) solutions. These systems can be as simple as the first order quadratic difference equation (which has application to population biology) or as complicated as certain partial differential equations (used to describe highly turbulent fluid flow). The concepts of entropy and ergodicity which were originally applied to thermodynamics are now being applied to much simpler systems. Our objective was to study the first order quadratic difference equation and other simple difference equations using these ideas.

METHODOLOGY AND RESULTS:

A good part of the investigator's time was spent reading the recent literature on the application of ergodicity and entropy to dynamical systems. A key quantity that gives much information about the mixing properties of a map is the Liapunov exponent. The investigator calculated this quantity for iterates of the quadratic map $y = rx(1-x)$. He also did several computer graphs of iterates of this map in the "chaotic region", $3.57 < r \leq 4$. These graphs illustrate nicely what has been shown theoretically; viz. that the quadratic map is totally ergodic on $[0,1]$ for $r=4$ and for certain special values of $r > 3.57$ has the property that a finite power is ergodic on certain subsets of $[0,1]$. The theory requires the notion of topological conjugacy which allows one to learn the mixing properties of a large class of maps by studying the behavior of the simplest one. The

investigator also generated some computer graphs of the complex function version of the quadratic map; this leads to curves called Julia sets.

STATUS:

The project is in its initial phase. Many more computations of Liapunov exponents and related quantities are required to illustrate the varied behavior of the maps (emphasizing those relevant to applications).

1984-1985

None

PRESENTATIONS:

"Logistic and Other Population Growth Equations," M.A.A. Conference Meeting, 10 May 1984.

"One and Two Dimensional Dynamical Systems", Mathematics Department Colloquium Talk, 11 Dec 1984.

"A Generalization of the Logistic Map to the Unit Interval," M.A.A. Section Meeting, 14 Apr 1984.

REFERENCES:

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- [3] P. Blanchard, Complex Analytic Dynamics on the Riemann Sphere, Bulletin of A.M.S., V.11, pp. 85-141, 1984.
- [4] P. Collet and J. P. Eckmann, Iterated Maps on the Interval as Dynamical Systems, Birkhauser, 1980.
- [5] P. Cvitanovic (ed.), Universality in Chaos, Hilger, 1984.
- [6] N. Martin and J. England, Mathematical Theory of Entropy, Addison-Wesley, 1981.

- [7] Y. Pesin, Characteristic Lyapunov Exponents and Smooth Ergodic Theory,
Russian Math. Surveys, V.32:4, pp 55-114, 1977.
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TITLE: Base Change for $SL(2)$ and Related Problems

INVESTIGATOR: Assistant Professor Courtney H. Moen
Mathematics Department

BACKGROUND:

There are many correspondences, some known and others conjectured, between automorphic representations of different reductive algebraic groups defined over a number field. One example is that of base change, which conjectures the existence of a correspondence between representations of GL_1 and those of GL_n , where E is a cyclic extension of a number field F . These correspondences must satisfy certain functorial properties. This problem has been investigated when $GL_1(2)$, $GL_1(3)$, $U(1,1)$, and $U(2,1)$. There is also a local analogue of the base change problem.

There are also correspondences between representations of a group and those of its covering groups in both the local and global situations. This problem has not received as much attention as base change. Only $SL(2)$ has been studied to any extent in this situation.

OBJECTIVE:

The primary objective of this project was to investigate the various aspects of the base change problem for the group $SL(2)$, both locally and globally. The related problem of the representation theory of the covering groups of $SL(2)$ and its connection with base change was also studied. A third topic that was considered involved the Weil representation and the three-dimensional unitary group over a p -adic field.

METHODOLOGY AND RESULTS:

The general method for approaching the problem of base change for $SL(2)$ is that of the trace formula and endoscopic groups. Much of the necessary work on functorial problems has been completed, and these results appear in (3). Analytic results have also been obtained. Many of the results from the representation theory of covering groups of $SL(2)$ which are necessary to study the connections with base change have been completed and appear in (1). With regard to the work on unitary groups, the results of (4), which were completed under the investigator's previous NARC grant, have been combined with more recent results in (5).

STATUS:

Reference (1) has been submitted. Reference (5), which includes the results of (4), will be submitted shortly.

REFERENCES:

- (1) Intertwining operators for covering groups of $SL(2)$ over a local field, pt. 1 (submitted).
- (2) Representation theory of covering groups of $SL(2)$ (in preparation).
- (3) Base change embeddings for $SL(2)$ (preprint).
- (4) The dual pair $(U(1), U(1))$ over a p-adic field (preprint).
- (5) The dual pair $(U(3), U(1))$ over a p-adic field (preprint).

TITLE: The Role of Perception in the U. S. - Japanese Security Relationship

INVESTIGATOR: Captain Kevin P. O'Keefe, USMC, Political Science Department

BACKGROUND:

With the announcement of the Guam Doctrine in 1969, the U. S. began the painful process of extricating itself militarily from Vietnam and pulling back from the Western Pacific. More than a decade later, due to this drawdown and increasing global commitments which have stretched U. S. forces to their limit, U. S. presence in East Asia is at its lowest level since prior to World War II. Coupled with the unprovoked build-up of Soviet military power in the region, this situation has raised genuine concern over the future security of the region.

During the last few years, the U. S. has brought more and more pressure to bear on Japan to shoulder an increasing amount of burden for its own defense and of the responsibility for regional security. To date, however, this effort has met with uncertain success.

A major reason for the lack of progress has been a failure of both sides to recognize that definite perceptual differences exist between Washington and Tokyo. Specifically, this "perception gap" encompasses fundamental differences in the basic threat definition (i.e., the type and degree of threat being faced in the Western Pacific), the appropriate response to the threat (i.e., what and how much), and the perceived capability to respond to such a threat (i.e., politically, economically and militarily). Further exacerbating this situation is a secondary, though not readily admitted to, problem of perception existing between officials in Washington charged with formulating U. S. Asian security policy, and those on-station in Tokyo who must deal directly with their Japanese counterparts.

OBJECTIVE:

This research project attempts to clearly separate and identify U. S. and Japanese perception of regional security needs which have hindered the translation of broad U. S. strategic needs in the Western Pacific into specific, mutually agreeable, defense guidance for Japan. The security role for Japan as seen by the U. S., and that which Japan sees for itself, is defined and compared as a basis for more effective security cooperation.

METHODOLOGY AND RESULTS:

The basic approach to this research was twofold. Initial investigation centered around an analysis of the evolution of U. S. security policy in East Asia over the past few years. This was accomplished primarily through access to documents at the Departments of Defense and State, and interviews with current key individuals in the policy-formulation process. Additionally, discussions were held with Japanese Embassy officials. The objective of this portion of the research was to establish Japan's role in East Asia as seen by the U. S.

The second phase of research involved on-scene interviews with both U. S. military and civilian officials at HQ, U. S. Forces, Japan and the American Embassy; and with Japanese military officers and civilians at the Japan Defense Agency and the Ministry of Foreign Affairs.

Based on this research, the "perception gap" was examined at two levels. First, whether or not a "gap" existed between those officials who formulate policy in Washington and those who carry it out in Tokyo was investigated. Secondly, a determination of whether there was an on-scene U. S. - Japanese military-to-military "gap" (i.e., Joint Staff Office, Japanese Self Defense Forces; and HQ, U. S. Forces, Japan), and a "gap" between those on the higher political-military level (i.e., Japan Defense Agency/Ministry of Foreign Affairs, and Department of Defense/State) was made.

While not revealing any startling information, this research did yield some very interesting perceptual differences in how the U. S. - Japanese security relationship is viewed from different levels and locations. Overall, U. S. military and civilian officials presented a consistent evaluation of the state of security affairs between the U. S. and Japan, and the direction that relationship is most likely to take in the future. There was agreement that Japan is doing as much as is politically possible at this time. A difference was noted, however, in the vigor with which this position was presented. Those individuals on-scene in Tokyo were very quick to point out that relations are as good as they have been in years. This was especially true of the U. S. military officers. Embassy officials, while very pleased with recent progress, were more reserved in their comments.

On the Japanese side, both in Washington and in Tokyo, senior military officers expressed the same observations as their American counterparts in uniform. They seek a greater defense effort on Japan's part, but realize the current political limitations involved with any rapid build-up. On the civilian side, however, officials at the Ministry of Foreign Affairs, while agreeing that security relations between the two nations were very good at this time, indicated that the future most probably would hold some rough times especially when (and not "if") Japan failed to live up to U. S. expectations. Further, these officials pointed out some weaknesses in the current relationship, something which no one else who was interviewed mentioned openly.

This research did point out a major weakness on the U. S. side. There appears to be a lack of officials at the working level, both military and civilian, who are well-founded in Japanese affairs, and more importantly, who are experienced in dealing with the Japanese themselves. In Washington, this research was constantly referred back to a single individual as the "duty expert." Likewise, in Tokyo, those assigned to the senior military staff and

the embassy seem to have a rather cursory background in Japan political military affairs. An inherent weakness in our system appears to be the emphasis on the generalist to the detriment of specialization. This is most vivid in the constant turn-over of key personnel both in Washington and in Tokyo. The Japanese, on the other hand, have officials who spend much longer portions of their career developing expertise in a particular area.

One final observation is that among mid-career level Japanese officers, there is a much greater desire for Japan to increase her efforts in the security area with an eye on a certain degree of self-sufficiency, relying on the U. S. only for its nuclear umbrella. Further, these junior officers are much more skeptical of the U. S. commitment to Japanese security, and openly question whether the U. S. would honor her security obligations toward Japan in all situations. Thus, it must be remembered that the U. S.-Japanese security relationship holds responsibilities for both parties. Indeed, the U. S. must not only work to foster more Japanese efforts in the area of defense, but also ensure that the U. S. commitment to Japan remains a credible one especially in the eyes of our Japanese allies.

STATUS:

A scholarly paper based on research findings is being prepared for eventual publication. Further, research materials have been successfully integrated into current political science courses on comparative Asian politics and international relations.

PUBLICATIONS: None

PRESENTATIONS: None

FILE: Thomas Carew and the Court of Charles I

INVESTIGATOR: Associate Professor Michael P. Parker, English Department

BACKGROUND:

Thomas Carew (1594/95-1640) is generally regarded as the most accomplished poet working at the Court of Charles I. Carew's poems span a wide range of genres--lyric, elegy, literary epistle, masque--and are of consistently high quality. His well known epistle to Ben Jonson and his elegy on John Donne establish his close yet discriminating relationship with the greatest poets of the early seventeenth-century; other poems suggest the formative influence he exerted on younger poets such as Suckling, Waller, and Wren. As Sewer in Ordinary to Charles I, Carew achieved a prominence at court that furthered his literary influence. He proves a reliable commentator on events at Whitehall and Greenwich, and his poems provide astute yet sensitive insights into the social and political attitudes of Charles and his court.

Despite his central role in the literature and politics of the 1620's and 30's, Carew has garnered little sustained critical attention. Although two books have appeared in the last twenty-five years, both are limited in scope. Neither addresses Carew's relations with literary patrons, a subject crucial to understanding his position amid the shifting political and personal alliances at the Caroline court. Nor has any work dealt with Carew's role as propagandist and polemicist or traced the motives behind his apparent alienation from the monarchy in the late 1630's.

Patronage and politics constitute only one aspect of the larger cultural question. During the past decade numerous scholars have investigated the image that the Caroline monarchy strove to present through a complex program of masques, entertainments, and iconographic schemes. The question that remains to be answered is how this sustained public performance affected the daily routines and private preoccupations of court life. A detailed study of Thomas Carew's career can go a long way toward resolving these issues.

OBJECTIVE: To write a book-length study that will gauge the extent of Carew's commitment to the courtly culture he helped to create and that will place his poetry firmly in the historical and cultural milieu he helped to foster.

METHODOLOGY AND RESULTS: During the spring of 1984 I reviewed the wealth of recent scholarship, both historical and literary, on England in the early seventeenth-century. Several promising new lines of investigation appeared; in particular, a new study of Queen Henrietta Maria's role in the political squabbles of the 1630's shed unexpected light on Carew's activities. During the summer I reread a good deal of the correspondence contained in the Records of State Papers and other collections in order to strengthen my grasp of the personalities and issues that dominated the life of the court during the period. In June and July 1984 I drafted two chapters dealing with Carew's poems on affairs of state and his poems addressed to private patrons.

ing the coming year I plan to revise these chapters, combine them with
ers already written, and prepare the manuscript for submission to a
isher.

US: The work continues as outlined above. My research has attracted some
olarly attention, and I have been asked to referee several papers in the
d.

ICATIONS: "Carew, Kit Villiers, and the Character of Caroline
rtliness" in Renaissance Papers (1984), pp. 89-102.

SENTATIONS: "The Lady's Not for Burning: Lucy, Countess of Carlisle,
ng the Poets," Modern Language Association of America, New York, NY, 28
ember 1983.

5) "Computer Modelling of Simple Point Defects in Rare Earth Doped
ine Earth Fluorides," J. Phys. C: Solid State Phys., 15 (1982),
3453. (Also in Conference Proceedings), with Kimble, Fontanella,
rsgill, and Andeen.

6) "Dielectric Spectroscopy in Rare Earth Doped Lead Fluoride," Solid
Chemistry 1982, Proceedings of the 2nd European Conference, Veldhoven,
rlands., ed. Metselaar, Heijligers, Schoonman, Studies in Organic
stry, 3 (1983), 219-222, with Fontanella, Wintersgill, Chadwick, Azimi,
and Andeen.

ENTATIONS (during NARC funding):

1) "Computer Modelling of Point Defects in the Alkaline Earth Fluorides,"
ican Physical Society March Meeting, 1981, Phoenix, Arizona, 17 March 1981.
i Fontanella and Wintersgill).

(2) See (4) under PUBLICATIONS above (presented by Fontanella).

(3) "The Relation Between Free and Bound Ion Motion in the Alkaline Earth
rides," post session, International Conference on Insulating Crystals, Riga,
ia, USSR, 18-23 May 1981, with Fontanella, Wintersgill, Chadwick, and Andeen
sented in absentia).

(4) "Pressure Dependent Electrical Properties of Some Fluorides," 13th
ington Area High Pressure Colloquium, Nov. 1981, NRL, with Fontanella,
ersgill, and Purse (presented by Fontanella).

(5) "Free and Bound Ion Motion," film/TV tape, shown at International
erence (Gatlinburg) May 1981 and NATO Advanced Study Institute (Lannion,
ce) July 1981. Abstract submitted for inclusion in Lannion Institute
eedings.

3. The investigator has completed the major portions of the data fitting gram, which has gotten quite lengthy. It has been useful in preliminary data ting. Results were reported at a conference. More extensive use of the gram will be made this fall.

TUS

The investigator intends to complete the installation of the N.I.H modelling kage. A member of the USNA Chemistry Department (Mark Elert) has expressed ie interest in this. The investigator expects to make increasing use of the elling program in fitting numerical data obtained by his colleagues in the ics Department. Two new types of experimental apparatus will shortly be in e, tripling the volume of data, and requiring fitting three distinct types of ations and data.

PLICATIONS (during NARC funding):

(1) "Activation Volume for Dimer Reorientation in Rare Earth Doped Calcium oride," J. Phys. C: Solid State Phys., 13, (1980), L661-666 with Fontanella, nble, Andeen, and Wintersgill.

(2) "The Relation Between Bound and Free Ion Motion in Some Fluorides," lid State Ionics, 5 (1981), 585-588, with Fontanella, Wintersgill, Chadwick, # Andeen.

(3) "Clustering in Rare-Earth-Doped Alkaline Earth Fluorides," J. Phys. C: lid State Physics, 14 (1981), 3557-74, with Andeen, Fontanella, Wintersgill, nble, and G. E. Mathews.

(4) "The Relation Between Bound and Free Ion Motion in Some Fluorides," ee above) Proceedings of the International Conference on Fast Ionic Transport Solids (Gatlinburg), with Fontanella, Wintersgill, Chadwick and Andeen.

The investigator also began writing an interactive command interpreter for graphical display and non-linear least-squares data fitting. Non-linear least squares data fitting is a difficult art at best. Graphics displays greatly enhance the speed with which a good fit to the data may be obtained.

METHODOLOGY AND RESULTS:

1. The investigator recently (Spring '84) became aware that work had been done at N.I.H. on a package of programs for modelling organic compounds. MMI was one component of this package, which provided other modelling tools in an interactive environment. There was in addition a command language interpreter, a common interface tying the different programs together, and a greatly simplified method for setting up data. Because data entry was proving to be a major nuisance with MMI, because of the comprehensive nature of the N.I.H. package, and because of the prospect of obtaining free of cost and labor any future N.I.H. enhancements, the investigator obtained a copy of the N.I.H. programs. There were perhaps 200 major subroutines; many thousands of lines of Fortran code.

I then began working on getting it all up and running on the CADIG VAX 11/780. The most difficult part, the command interface, is running and partially debugged, with about 60% of the total code converted. The remaining portion should be more straight-forward, as it is numerical in nature. I hope to interest the Chemistry Department in helping complete this project, as the package is of potential interest for use by their faculty and students.

2. It came to my attention that CADIG had state-of-the-art molecular-display software from the University of North Carolina. This software needed installation and assimilation, there being no local "expert" on it. This was done by the investigator. With a very small amount of work, the output from the N.I.H. package can now be fed to these programs, producing three-dimensional color displays of organic molecules (of up to about 400 atoms). This would greatly assist understanding of the structure of those molecules.

ITLE: Computer Analysis of Polymer Structures

INVESTIGATOR: Associate Professor Peter J. Welcher
Mathematics Department

ACKGROUND:

Certain polymers become conductors of electricity when doped with various ions. By stacking and heating thin sheets of such polymers, one may construct a working battery. It is thought that batteries which are lighter and less bulky than current batteries can be constructed from these inexpensive materials. This would be very useful to the Navy. In order to do this reliably, more information about conduction mechanisms is needed. Such information assists in evaluating the relative merits of different ionic dopants, and in estimating the physical characteristics of polymeric batteries. It could also suggest how to lower the operating temperatures of such batteries.

The experimental data obtained thus far contains far more complicated dielectric spectra than the work on crystals done earlier by this group. Quantitative evaluation of this data presents interesting problems in non-linear least squares data fitting.

The investigator had previously obtained a polymer modelling program, MMI, written by N. Allinger of the University of Georgia. I made substantial changes in it, to convert it from a format suitable for the batch processing of a deck of cards, to an interactive format suitable for the time-sharing system, NATS. Graphical display programs were written, producing monochromatic Tektronix terminal display. Because of the difficulty in setting up data for a program run, an effort was made to write a data-preparation program.

PUBLICATIONS:

- (1) A Family of Quadratic Forms Associated to Quadratic Mappings of Spheres, to appear in Linear Algebra Appl.
- (2) A Quadratic Form Associated to Hopf Maps, to be submitted.
- (3) On Some Constructions of Normed Bilinear Maps, in preparation.

PRESENTATIONS:

- (1) A Family of Quadratic Forms Associated to Quadratic Mappings of Spheres, 90th annual meeting of AMS, Louisville, Ky., 27 January 1984.

Similar results are obtained for $f(2n + 1, p)$, $n = 3, 4, \dots$ where congruence classes of $p \bmod (2^k)$ are considered.

The difficult question of obtaining strictly admissible triples (p, q, r) has been solved in a few cases. (e.g., $(p, q, r) = (3, 5, 7)$). A map for $(p, q, r) = (10, 10, 16)$ is constructed. This triple is shown to be strictly admissible by the results of H. Hopf.

Bilinear maps corresponding to an admissible triple (p, q, r) are essential ingredients in certain quadratic mappings of spheres. These maps are called Hopf maps, due to their resemblance to the classical Hopf fibrations. For a given Hopf map $f: S^{n-1} \rightarrow S^{m-1}$, with $f = (f_1, \dots, f_m)$ a quadratic form $M(f)$ is defined as follows:

$$M(f) = (m_{ij}), m_{ij} = \frac{m}{a_{n-1}} \int_{S^{n-1}} f_i f_j dw, \text{ where } a_{n-1} \text{ is the}$$

surface area of the unit sphere S^{n-1} with respect to the standard measure dw . There is much evidence to support the conjecture that, for integral Hopf maps, the forms $M(f)$ and $M(g)$ lie in distinct isometry classes over the field of rational numbers, if the associated bilinear maps correspond to strictly admissible triples and the maps f and g are not equivalent under action of the orthogonal group.

STATUS:

Work is continuing on the problem of identifying strictly admissible triples using numerical invariants, such as those corresponding to the quadratic form defined above. The results involving the construction methods are currently being prepared for publication.

METHODOLOGY AND RESULTS:

The methods used in this investigation involved explicit constructions arising from Clifford algebras and their representations. Let (X, q_X) and (Y, q_Y) be quadratic spaces of dimension p, m over F . Choose an element $e \in X$ such that $q_X(e) = 1$ and put $X = Fe \perp X_1$, with respect to q_X . Let $C = C(-q_{X_1})$ be the Clifford algebra of $-q_{X_1}$, where $q_{X_1} = q_X|_{X_1}$. Denote by $"-"$ the unique involution of C such that $\bar{x} = -x$ for all x in X_1 . Let $*$ be the involution of $E = \text{End}(Y)$ associated to q_Y . There is a one-to-one correspondence between bilinear maps $B: X \times Y \rightarrow Y$ such that $q_Y(B(x, y)) = q_X(x)q_Y(y)$ and elements λ in $\text{Hom}((C, -), (E, *))$ given by $B(x, y) = \lambda(x)y$, where $\lambda(\bar{x}) = \lambda(x)^*$. Given a bilinear map $B: F^p \times F^m \rightarrow F^m$, $B(x, y) = \phi(x)y$ with ϕ in $\text{Hom}(F^p, GL_m(F))$, the idea is to restrict to certain subspaces in order to obtain a map $B: F^s \times F^k \rightarrow F^l$, with $B(x, y) = \lambda(x)y$, where λ is a representation of a Clifford algebra in the category of algebras with involution, as described above. ($s \leq p$ and $k, l \leq m$).

This method has yielded the following results. The triples (p, q, r) are admissible for $r = f(q, p)$ for the following:

$$\begin{aligned}
 1. \ f(2, p) &= \begin{cases} p & p \equiv 0(2) \\ p+1 & p \equiv 1(2) \end{cases} \\
 2. \ f(3, p) &= \begin{cases} p & p \equiv 0(4) \\ p+2 & p \equiv 1, 2(4) \\ p+1 & p \equiv 3(4) \end{cases} \\
 3. \ f(5, p) &= \begin{cases} p & p \equiv 0(8) \\ p+4 & p \equiv 1, 2, 3, 4(8) \\ p+3 & p \equiv 5(8) \\ p+2 & p \equiv 6(8) \\ p+1 & p \equiv 7(8) \end{cases}
 \end{aligned}$$

TITLE: Products of Sums of Squares

INVESTIGATOR: Assistant Professor JoAnn S. Turisco
Mathematics Department

BACKGROUND:

The problem under consideration is the study of formulas of the type:
 $(x_1^2 + \dots + x_p^2)(y_1^2 + \dots + y_q^2) = z_1^2 + \dots + z_r^2$, where $x=(x_1, \dots, x_p)$ and $y=(y_1, \dots, y_q)$ are systems of indeterminants, and each z_i is bilinear in x and y with coefficients in a field F (of characteristic not two). A triple (p,q,r) is called admissible over F if such a formula exists. This outstanding question has a long and interesting background dating back to A. Hurwitz in 1898. He showed that (p,p,p) is admissible over the field of complex numbers precisely when $p=1,2,4$, or 8 . The next breakthrough occurred when Radon (1921) and Hurwitz (1923) proved that (p,r,r) is admissible over the real field R if and only if $0 \leq p(r)$. Here $p(r) = 8a + 2^b$ where $r = 2^m u$ (u odd) and $m = 4a + b$. ($0 \leq b \leq 3$) In 1940, H. Hopf used topological methods to deduce some nonexistence criteria for certain sum-of-squares identities over R . Behrend (1939) obtained similar results using real algebraic geometry. Recently, some notable advances have been made by J. Adem, K. Y. Lam, T. Y. Lam, and Yuzvinsky.

OBJECTIVE:

The investigator had two objectives. The first was to characterize those admissible triples (p,q,r) where r is not equal to p or q . A triple (p,q,r) is called strictly admissible if r is the smallest value which makes (p,q,r) admissible, for fixed values of p and q . The second objective was to identify strictly admissible triples.

lopment of the intellect, to the humane growth of the culture, to social and political justice, on the one hand, and to technological progress, moral courage, and the defense of Western Civilization, on the other. These two naval professionals have contributed to both ends of this spectrum by their writings, and by their work."

STATUS: The essay described above--entitled "Of Liberal Education and the Naval Profession"--is complete.

PUBLICATIONS: The essay was submitted on 5 September 1984 to a prominent national humanities journal.

PRESENTATIONS: None as yet.

TITLE: Of Liberal Education and the Naval Profession: A Study

INVESTIGATOR: CDR Robert E. Shenk, USNR, English Department

BACKGROUND: Among the most fascinating stories of the past twenty years have been those of two American naval professionals who immersed themselves for long careers in the practical problems of the United States Navy, and then surfaced to speak to the critical importance of the liberal arts to those same careers.

One of these was the career naval machinist's mate, Richard McKenna, who on retirement as a Chief Petty Officer took up creative writing, and suddenly burst on the public scene with The Sand Pebbles, an enormously successful and very high quality novel about the Chinese Rebellion of 1926-7. In one of the speeches he delivered after his novel's success, he revealed that what had kept his mind alive all his years in the engine-rooms of the Pacific Fleet was his devotion to English poetry, books of which he habitually stashed in crannies of the engineering spaces aboard ship.

The other is Vice Admiral James Bond Stockdale (Retired), who in the midst of a highly successful career as a naval aviator was forced to endure eight years as a POW in Vietnam. On leaving captivity he resumed his career in the Navy, then published an essay in The Atlantic Monthly revealing that it was the liberal arts--the classics of philosophy, literature and history, especially, but also education in political science and training in drama--which had kept him spiritually alive while in that desperate situation.

OBJECTIVE: These two men have spoken eloquently to the importance of the liberal arts from the perspective of one particularly challenging profession with intelligence, style, and authority. However, although their careers have awakened interest and curiosity, their opinions, their histories, and the general significance of their experience in relation to the liberal arts are not widely known outside the naval service. The objective was to study carefully all the writings of these men, and then to compose a comparative essay on their careers and writings as related to the humanities.

METHODOLOGY AND RESULTS: By means of an extended comparison, I concluded as follows:

"Stockdale was imbued with the military ethic: honor, obedience, responsibility, patriotism, courage, community. In all these ways the military ideal is to live for something beyond self. And while McKenna was not so deeply influenced by military values, his dedication to engineering was a great source of strength and insight, also teaching him the importance of duty and community, strong themes in all his fiction. The values these men cherished and supported are very old-fashioned ones--integrity, friendship, justice, compassion, decency. But, then, so are the authentic values of the liberal arts. Both the military ethic and genuine professionalism of any kind are true complements to liberal education. Admittedly, militarists and careerists can pervert the humane ends of their professions, but when intellectuals lack principles they do the same thing. If they are to be true to their callings, humanists and professionals alike will be dedicated to the same basic goals: to the deve-

Finally, the use of photochemical techniques to generate tin-amide derivatives of molybdenum and chromium carbonyl complexes under air-sensitive conditions has been initiated. Identification of isomeric products using spectroscopic techniques will be pursued. These studies are an extension of preliminary work done elsewhere and will continue in collaboration with Prof. C.D. Schaeffer at Elizabethtown College.

STATUS: At this time, the work on the phase-transfer catalysis project is continuing. Synthesis and characterization of the substituted allyl derivatives of ruthenium continues. Characterization using Nuclear Magnetic Resonance spectroscopy is possible for the crotyl products however further purification of the desired species is necessary.

Generation of the isocyanide-metal complexes is an ongoing project. Reaction with the olefinic ligands is under investigation and the products obtained characterized using the department Nuclear Magnetic Resonance spectrometer and FT Infrared spectrometer. Addition of various nucleophiles to the olefin ligand on the metal will then be investigated.

Chromium complexes containing carbonyl ligands and phosphine or phosphite ligands have been synthesized and sent to the Italian research chemists for characterization using their high resolution NMR instrument. The generation of these complexes is possible using photochemical techniques, however yield and purity are affected by the temperature of the reaction medium. Investigation of this temperature dependency is being conducted.

Tin-amide ligand has been received from Professor C. D. Schaeffer of Elizabethtown College. Other derivatives of this ligand are being prepared by Professor Schaeffer and will be forthcoming. An inert atmosphere drybox has been obtained and is being outfitted with necessary equipment for the synthesis of these metal complexes. An inert atmosphere vacuum line is currently being assembled to allow the handling of these materials in a purified atmosphere yet out of the drybox confines.

PUBLICATIONS: Submitted in collaboration with B. V. Johnson, D. H. Gibson, W. -L. Hsu and C. D. Schaeffer, Jr to *Inorganica Chimica Acta* and accepted for publication: "Photochemical Reactions of Bis(bis(trimethylsilylamido)tin (II) with Hexacarbonylmolybdenum and Tungsten."

"Synthesis of Stereoisomeric - Metal Complexes Using Phase-transfer Catalysis and Photochemical Transforms," a Trident Scholar Project Report (#128) prepared and submitted by Midshipman Douglas J. Brown, 1/C (1984) under the direction of Professor J. E. Shade.

PRESENTATIONS: Douglas J. Brown and J. E. Shade, "Syntheses of Allyl and Crotyl Derivatives of Pentahapto-cyclopentadienyl Metal -carbonyl Complexes Using Phase-transfer Conditions," 1984 Intercollegiate Student Chemists Convention, Lancaster, PA, April 1984.

TITLE: Generation of Transition Metal Complexes by Phase-Transfer Catalysis and Photochemical Techniques

INVESTIGATOR: Joyce E. Shade, PhD., Assistant Professor, Chemistry Department

BACKGROUND: Organometallic compounds of the general form $(\eta^5\text{-C}_5\text{H}_5)\text{M}(\text{CO})_2\text{R}$ where R = an organic ligand have traditionally been obtained through the reduction of the dimeric species $[(\eta^5\text{-C}_5\text{H}_5)\text{M}(\text{CO})_2]_2$ using a sodium-mercury amalgam in tetrahydrofuran solvent. Such processes generally require several hours for the actual reaction time followed by a multistep purification procedure. Recently, a technique known as phase-transfer catalysis (PTC) has been suggested as an alternative approach to the conventional synthesis of such compounds. Phase-transfer catalysis conditions involve using an aqueous base-organic solvent two-phase media in which a quarternary ammonium salt is the catalyst. Because these PTC reactions are often conducted under mild conditions, are rapid and require simplified workups, the broad applicability of this method is under further investigation.

A second technique which can be used for the selective synthesis of organometallic compounds involves the use of high energy light to initiate chemical reactions. Unlike thermal reactions which frequently result in undesired side-products or decomposition, careful control of the wavelength of incident radiation results in the selective excitation of molecules or parts thereof, while the other parts of the molecule remain unaffected. In addition, many reactions which cannot be induced by thermal methods can be initiated using photochemical techniques. Three systems which are under current investigation are 1) the isocyanide - metal complexes homologous to the previously mentioned cyclopentadienyl-carbonyl-metal series, 2) phosphine and phosphite derivatives of fluorene chromium carbonyl and 3) tin-amide derivatives of molybdenum and chromium hexacarbonyl.

OBJECTIVE: The overall objective of this research is to develop high-yield, selective synthetic routes for the synthesis of organometallic compounds. A particular emphasis will be on the use of phase-transfer catalysis and photochemical techniques.

METHODOLOGY AND RESULTS: The first part of this research has focused on the reaction of organohalides with $(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2\text{X}$ where X = a halogen. Studies with CH_3I were unsatisfactory due to a competitive reaction in which a dimer of the starting material was formed. A reexamination of literature reports by D. H. Gibson of the reaction of allyl with $(\eta^5\text{-C}_5\text{H}_5)\text{M}(\text{CO})_2\text{X}$ was undertaken to clarify the experimental procedures. After extensive work and some modification of the reported reaction conditions, it was possible to develop an expertise in the use of the PTC techniques. An extension of these synthetic techniques using crotyl halides and other allyl derivatives has been investigated and produced positive preliminary results. Additional work on this area is in progress.

The second part of this research has been directed towards the use of photochemistry to prepare substituted metal complexes. Isocyanide complexes of the form $(\eta^5\text{-C}_5\text{H}_5)\text{M}(\text{CNR})_n$ have been prepared and an ethylene complex has been generated photochemically.ⁿ The research in this area continues with expectations of the synthesis of several olefinic derivatives with subsequent reaction with nucleophiles to generate sigma-bonded alkyl complexes.

In collaboration with Italian researchers at the University of Padua, the synthesis of a series of phosphine and phosphite substituted fluorene chromium carbonyl complexes using photochemical techniques has been initiated. These complexes will be used in a broad spectroscopic investigation of haptotropic rearrangements.

I consulted many of these documents in the departments of the Yonne, the Loiret and the Yvelines in order to determine the social background of young women who attended these normal schools. In the department of the Yonne, I was fortunate enough to discover a normal school register for the period 1872-1890 that contained extensive information on the women at Auxerre. This document told me not only when and where the students were born, but more importantly, what their fathers did and how their career progressed after graduation from the normal school. In the departments of the Loiret and the Yvelines, research yielded important information on the students' social background, but through a more arduous route of investigation. At Orleans and Versailles, I used numerous birth records and census reports to locate these women students. During the course of eight weeks in France, I believe that I uncovered an extensive amount of original data that will eventually allow me to evaluate the impact of the normal schools' social program.

STATUS: Most of the research for this project is now finished. I would like to correspond with the departmental archives in the Jura in order to determine whether or not a normal school register of the quality of the one in the Yonne is catalogued among their documents. The existence of such a document is, however, not crucial to the project. Meanwhile, I am currently organizing this new wealth of information. During the first weeks of the summer, I began a redrafting of the manuscript. The new information on the students' social background will be invaluable as I draw a larger picture of the impact of popular education for the common people in the nineteenth century.

PUBLICATIONS: "Clean and Decent Students: Health Care Practices Inside Women's Normal Schools, 1830-1900, " in Proceedings of the Tenth Annual Meeting of the Western Society for French History, John F. Sweets, ed. Lawrence, Kansas: University of Kansas, 1984, pp. 394-403.

PRESENTATIONS: "The Primary Schooling of Girls and the Second Empire," paper proposed for the Society for French Historical Studies, 22-23 March 1985 at the University of Southern California.

TITLE: Popular Education in nineteenth century France: A Social History of the Women's Normal Schools

INVESTIGATOR: Assistant Professor Anne T. Quartararo, History Department

BACKGROUND: This research project is an examination of the social values and academic mission of teacher-training schools in France during the nineteenth century. The study of these normal school institutions offers a concrete way to analyze the formation of a national society in France. As a rule, European governments by the second half of the nineteenth century became increasingly concerned about the education of the common people. Politicians throughout the West developed strategies that required a commitment to popular education as a way to mold a loyal and disciplined group of citizens. In France, a national network of normal schools for primary instruction reflected such a government commitment. My study has focused, in particular, on the women's normal schools because government officials soon realized that their idea of a progressive, orderly, and productive society depended as much on the women who cared for the home environment as upon the men who functioned in the marketplace. By the last two decades of the nineteenth century, the women's normal schools of the Third Republic were training an elite corps of young women for primary schooling. These lay women teachers served as representatives of the national government's social program in even the most remote regions of France.

The core of my study has taken up the problems of curricula, the range and depth of course work at the normal schools, and the concomitant issue of inculcating social values during the three year school program. I have found that while curricula became more demanding at these training schools by the end of the nineteenth century, social values were no less important and perhaps played a greater role in forming a national society. In fact, daily life at the normal schools only reflected and reinforced values inherent to the academic program. My research has shown that these training schools gave their students a strong sense of "corporate identity" which affected relations between students during their tenure at school and colored behavior among colleagues long after they entered the profession. In sum, by the end of the nineteenth century, many common people in France were gradually beginning to identify with a national society. The success of the government's mission depended on a strong commitment to popular education. The normal school network guaranteed a sizable and well-trained female teacher corps to instruct children of the common folk in loyalty and duty to their country.

OBJECTIVE: I am currently preparing a book-length manuscript on popular education in nineteenth century France.

METHODOLOGY AND RESULTS: Most of the research for this study comes directly from archival sources in the National Archives in Paris and the departmental archives in the French provinces. At the National Archives, I have already consulted numerous reports by inspectors and normal school officials catalogued in the F¹⁷ series. Reports on disciplinary action are also found in this large series. In the provinces, reports on the development and progress of the normal schools are registered under the T series. During the summer of 1984,

(6) "Computer Calculation of the Effect of Pressure on Motional Enthalpies in the Alkaline Earth Fluorides," American Phys. Society, Dallas, Texas, March 1982, with Wintersgill and Fontanella (presented by Fontanella).

(7) "Dielectric Spectroscopy in Rare Earth Doped Lead Fluoride," 2nd European Conference on Solid State Chemistry, June 1982, Netherlands, with Fontanella, Wintersgill, Chadwick, Azimi, Carr, and Andeen. (presented by Fontanella).

(8) "Computer Modelling of Activation Enthalpies in Strontium Fluoride," American Physical Society March Meeting, Los Angeles, 23 March 1983, with Fontanella and Wintersgill.

(9) "Universal Curves and Normalizing Dielectric Relaxation Data," International Conference on Defects in Insulating Crystals, University of Utah, Salt Lake City, 21 August 1984, with Fontanella and Wintersgill.

Title: Reliability Analysis of Ship Structures in a Seaway

Investigator: Assistant Professor Gregory J. White, Naval Systems
Engineering Department

Background:

The structural weight of Naval surface combatants constitutes approximately 35% of the total lightship displacement; making hull structures the heaviest of all ship subsystems. Any improvements in vessel capability through growth of the mission related payload will necessitate an equivalent reduction in weight in some other subsystem. Because of the proportionally low cost of the hull subsystem, improvements can be made without drastically increasing total vessel cost by reducing the structural weight.

How can structural weight be reduced? The use of new materials and technologies can provide a means of making the vessel lighter. But what about vessel strength? Current design rules or "scantlings" will become invalid or unrealistic as new materials and technologies are introduced. This is because the rules are not based on rational analytical methods, but rather on a mixture of historical data and empirical approximations with hidden factors of safety. The use of these rules can possibly lead to over designing the structure, or worse, under designing it without proper estimation of safety.

Consequently, improved design rules and analysis methods need to be developed. These methods should be capable of handling the new technologies and materials as well as existing ones. Since the loading of a ship structure is mainly the sea, a truly random system, the most appropriate new method should be one which takes into account the randomness of both loading and structural properties to estimate the risk of unacceptable response. Many reliability, or risk estimation methods have been proposed which consider these parameters. Uncertainties are modeled in terms of the mean, the variance, and the probability density and distribution functions. The limitations and assumptions involved in each method are a result of how that method uses part or all of the statistical information available.

Objective:

To develop a plan or action for completing a long-range investigation into ship structural reliability. Once the necessary steps or objectives are identified, begin to develop a solution to each objective.

Methodology and Results:

The background investigation and the literature search identified the following primary objectives for the research proposed:

- a. To evaluate the available different reliability models based on their efficiency and accuracy in estimating the reliability of ship structures. First-Order, Second-Order Second-Moment, Advanced Second-Moment, and Variance Reduction Techniques will be considered. The accuracy of each technique will be estimated in terms of the variance of the estimated output quantity, i.e., the probability of failure of a structural element. On the other hand, the efficiency

of each technique will be estimated based on the needed analyst and computer times, and computer memory.

- b. To perform analysis of uncertainties associated with ship hull strength and loading. Uncertainty analysis can be performed by: (1) probabilistic analysis, and (2) conceptual analysis. Probabilistic analysis of uncertainties requires sufficient data base. However, some probabilistic factors which affect the uncertainties do not have enough information to develop a statistical pattern. They need to be updated as information becomes available. In this case, the statistical Bayesian updating approach can be used. In other cases, conceptual factors which affect the uncertainties in strength and loading of ship hulls can be expressed in qualitative or linguistic terms instead of quantitative terms. Factors such as level of war intensity, experience of the ship's captain and vessel seaworthiness fall into this category. These factors are often neglected in present analysis techniques. In the proposed research, these sources of uncertainties will be studied and techniques to reliably estimate them will be developed. These techniques will be based on probability, statistics and fuzzy sets theory.
- c. To perform analysis of consequences of the different failure modes of ships. A method of estimating the consequences will be proposed based on fuzzy sets theory. The consequences will be estimated in terms of the degrees of seriousness of structural failure in regard to safety and serviceability.
- d. To study the different failure modes of hull structures designed based on current design criteria, and to estimate the risk associated with each failure mode.
- e. To verify the proposed mechanisms developed by comparing the estimated output quantities with any available data and/or experts' opinion.

The uncertainties cannot be removed completely. However, when they are modeled appropriately, the proposed mechanisms will give results close to the real world, and ultimately the results of this study can be used to define new criteria for ship design and maintenance of ship structures.

Objective (a) was undertaken and the results reported in the paper identified below. The method chosen was simulation using variance reduction techniques. This method is capable of handling complex problems such as cases involving load combinations and/or coupling of failure mechanisms.

Status:

With the identification of the objectives of this investigation and the development of a suitable reliability model it can safely be said that the research is well on its way. This investigator is planning to continue work on this subject as funding becomes available.

Publications:

White, G. J. and Ayyub, B. M., "Reliability Methods for Ship Structures," paper currently under consideration by the American Society of Naval Engineers for publication in the ASNE Journal.

Presentations:

"Reliability Methods for Ship Structures," under consideration for ASNE Day Meeting, 3 - 4 May 1985.

TITLE: The Weil Transform and the Uncertainty Principle

INVESTIGATOR: Assistant Professor William E. Yancey
Mathematics Department

BACKGROUND:

The Fourier Transform is used in signal processing to transform a signal $f(t)$ in the time domain to its Fourier transform $F(\omega)$ in the frequency domain. One then searches for peaks of the modulus $|F(\omega)|$ corresponding to characteristic frequencies ω . Various versions of the uncertainty principle are statements of inherent limitations of this process for short duration signals; that is, for various families of functions or different definitions of duration, the uncertainty principles state that the time-band duration of the signal and the frequency-band duration of the transform are in inverse proportion. Thus short duration signals have wide frequency bands, over which it is time-consuming to search for peak frequencies.

METHODOLOGY AND RESULTS:

By restricting the Weil Group representation to the rotation group, one obtains a one-parameter family of integral transforms, which we call collectively the Weil Transform. When the parameter is $\frac{\pi}{2}$, the Weil Transform corresponds to the Fourier Transform; when the parameter is 0, the Weil Transform corresponds to the identity transform; for intermediate values of the parameter, the transform interpolates between the identity and the Fourier transform. Moreover, since the Weil Transform derives from a representation, the Weil Transform obeys a composition law. Thus we can obtain an "nth root" of the Fourier Transform, in the sense of an integral transform whose nth iteration corresponds to the Fourier Transform.

By using this fractional Fourier Transform, one can obtain modified versions of various uncertainty principle results. We prove the modified inequalities and obtain the functions for which the lower bounds are achieved for the standard Heisenberg uncertainty principle, the time- and band-limited restricted cases, and the Slepian-Pollack-Landau energy concentration cases.

STATUS:

The above constructions having been made and the above facts proved, a prima facie case has been made that the Weil Transform may be of some practical use in the analysis of short time-duration signals. The next reasonable step is to try to implement the computation of the Weil Transform, possibly using a digital analogue if some efficient algorithm can be developed.

PUBLICATIONS:

Wm. E. Yancey "The Weil Transform and the Uncertainty Principle" submitted to SIAM Journal of Mathematical Analysis.

PRESENTATIONS:

"The Weil Transform" USNA Math Dept Colloquium.

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